HAND-BOOK

TO THE

LOCAL MARINE BOARD EXAMINATION,

FOR

THE OFFICERS

OF THE

BRITISH MERCANTILE MARINE.

THIRD EDITION.

London;
PUBLISHED BY MRS. JANET TAYLOR,
AT HER NAUTICAL ACADEMY AND NAVIGATION WAREHOUSE,
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PREFACE.

IT being now incumbent on all Officers of the British Mercantile Marine to pass an Examination before the Local Marine Board, in order to test their efficiency for their respective grades, the following pages will be found to contain such portions of the Examination as are required,—independent of Seamanship, which can only be obtained by service at sea.

The Arithmetical Questions and Exercises in Logarithms, which have been introduced at the commencement, will be found useful, as preparatory to the Examples in Nautical Astronomy.

In the Answers to the Questions in Navigation, it has been thought sufficient to give only the more prominent portions of the solution, thereby leaving the student to do some thing for himself, by studying the Rules in the Epitome, and endeavouring to fully understand the use of Logarithms, and other Tables. If properly and accurately worked out, the answers should not deviate in any case, more than from 5″ to 10″ from those given, such difference arising from the Dip and Refraction Tables which the student may

use. It cannot be too deeply impressed on all, that an accurate knowledge of Time is essentially requisite, without which no Question in Nautical Astronomy can be correctly solved.

The instructions for Stowing Cargo, are those recommended by Lloyd's. In respect to Charter-party, Bills of Lading, Bottomry Bonds, &c. it has been the object merely to give a general knowledge of the subjects, and to indicate what is required by them; for the entire description and requirements of such documents cannot be given in brief, in such a manner as to make the young Master fully acquainted with them, as condensation of such matter frequently involves obscurity; and it is encumbent on every Master to understand thoroughly the Laws of Shipping, for which purpose reference must be made to the Works of Abbot, McCulloch, Steel, Lees, &c.

The Article on "Storms," will be found to contain all the most valuable practical information on the subject.

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EXTRA EXAMINATION:

P. 23	Top of each Days Work,	*for*	F.	*read*	$\frac{1}{10}$
24	line 13	*for*	elipticity	*read*	ellipticity.
26	31	,,	accomplish	,,	accomplish.
37	10	,,	substractive	,,	subtractive,

NOTICE

OF

EXAMINATIONS OF MASTERS AND MATES,

Established in pursuance of the Mercantile Marine Act, 1850,

AND OF

VOLUNTARY EXAMINATIONS IN STEAM.

To come into operation on the 1st September, 1852.

No *Foreign-going vessel is permitted to clear out from any custom house in the United Kingdom, unless the masters and mates respectively are in possession of Certificates, either of Service or of Competency.

The Certificate of Service entitles an officer, who has already served as either master or mate in the British merchant service before the 1st January 1851, to go in those capacities again, and may be had by application to the Registrar-General of Seamen, Custom House, London, on the transmission of the necessary certificates and testimonials.

Certificates of Competency will be granted by the Board of Trade, to all mates and masters who have passed examinations, whether under the old or present regulations, and also to all officers who have passed Lieutenants, Masters, and Second Masters examinations in the Royal Navy and East India Company's service, unless special reasons to the contrary exist; and any person desirous of changing a passing certificate—obtained under the former Boards of Examiners—for a Certificate of Competency, should send it to the Registrar-General, as before

* By a Foreign-going vessel is meant one which is bound to some place out of the United Kingdom, beyond the limits included between the rivers Elbe and Brest.

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mentioned, with a request to that effect, and state the port to which he wishes it to be sent, where it will be delivered to him by the Collector of Customs or the Shipping Master.

All other officers, entering for the first time upon their duties, whether as mate or master, will be required to undergo an examination before one of the Local Marine Boards before they can act in either of those capacities.

The examinations required for qualifications for the several ranks under mentioned, are as follow:—

A SECOND MATE must be seventeen years of age, and must have been four years at sea.

IN NAVIGATION.—He must write a legible hand, and understand the four first rules of arithmetic, and the use of logarithms. He must be able to correct the courses steered for variation and leeway, and find the difference of latitude and longitude therefrom; be able to correct the sun's declination for longitude, and find his latitude by meridian altitude of the sun; and work such other easy problems of a like nature as may be put to him. He must understand the use of the sextant, and be able to observe with it, and read off the arc.

IN SEAMANSHIP.—He must give satisfactory answers as to the rigging and unrigging of ships, stowing of holds, &c.; must understand the measurement of the log-line, glass, and lead-line; be conversant with the rule of the road, as regard both steamers and sailing-vessels, and the lights carried by them.

An ONLY MATE must be eighteen years of age, and have been four years at sea.

IN NAVIGATION.—In addition to the qualification required for a Second Mate, an Only Mate must be able to work a day's work complete, including the bearing and distance of the port he is bound to by Mercator's method. He must be able to observe, and calculate the amplitude of the sun, and deduce the variation of the compass therefrom. He must know how to lay off the place of the ship on the chart, both by bearings of known objects, and by latitude and longitude. He must be

able to use a sextant and determine its error, and adjust it, and find the time of high water from the known time at full and change.

In Seamanship.—In addition to what is required by a Second Mate, he must know how to moor and unmoor, and to keep a clear anchor; to carry out an anchor; to stow a hold; and to make the requisite entries in the ship's log.

A FIRST MATE must be nineteen years of age, and have served five years at sea, of which one year must have been as either Second or Only Mate, or as both.*

In Navigation.—In addition to the qualification required for an Only Mate, he must be able to observe azimuths and compute the variation; to compare chronometers and keep their rates, and find the longitude by them from an observation by the sun; to work the latitude by single altitude of the sun, off the meridian; and be able to use and adjust the sextant by the sun.

In Seamanship.—In addition to the qualification required for an Only Mate, a more extensive knowledge of seamanship will be required, as to shifting large spars and sails, managing a ship in stormy weather, taking in and making sail, shifting yards and masts, &c., and getting cargo in and out; and especially heavy spars and weights, anchors, &c.; casting ship on a lee-shore; and securing the mast in the event of accident to the bowsprit.

A MASTER must be twenty-one years of age, and have been six years at sea, of which one year must have been as First or Only Mate, and one year as Second Mate; or two years as First and Only Mate.*

In addition to the qualification for a First Mate, he must be able to find the latitude by a star, &c. He will be inquired

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* Service in a superior capacity is in all cases to be equivalent to service in an inferior capacity.

of as to the nature of the attraction of the ship's iron upon the compass, and as to the method of determining it. He must possess a sufficient knowledge of what he is required to do by law, as to entry and discharge, and the management of his crew; as to penalties and entries to be made in the official log. He will be questioned as to his knowledge of invoices, charter-party, Lloyd's agent, and as to the nature of bottomry, and he must be acquainted with the leading lights of the channel he has been accustomed to navigate, or which he is going to use.

In cases where an applicant for a certificate as master ordinary has only served in a fore and aft rigged vessel, and is ignorant of the management of a square rigged vessel, he may obtain a certificate on which the words *"fore and aft rigged vessel,"* will be written. This is not, however, to apply to Mates, who, being younger men, are expected for the future to learn their business completely.

An EXTRA MASTER'S EXAMINATION is intended for such persons as are desirous of obtaining command of ships and steamers of the *First Class.* Before being examined for an Extra Master's Certificate, an applicant must have served one year either as a Master with an *ordinary Certificate of Competency,* or as a Master having a *First Class Certificate,* granted by one of the former Board of Examiners.

IN NAVIGATION.—As such vessels frequently make long voyages, to the East Indies, and the Pacific, &c. the candidates will be required to work a lunar observation by both sun and star; to determine the latitude by the moon and star, by Polar star off the meridian, and also by double altitude of the sun, and and to verify the result by Sumner's method. He must be able to calculate the altitudes of the sun or star, when they cannot be observed, for the purpose of lunars; also to find the error of a watch, by the method of equal altitudes; and to correct the altitudes observed with an artificial horizon.

He must understand how to observe and apply the deviation of the compass; and to deduce the set and rate of the

current from the D. R. and observation. He will be required to explain the nature of Great Circle sailing, and know how to apply practically that knowledge; but he will not be required to go into the calculations. He must be acquainted with the Law of Storms, so far as to know how he may probably best escape those tempests common to the East and West Indies, and known as hurricanes.

In Seamanship.—The extra examination will consist of an inquiry into the competency of the party to heave a ship down, in case of accident befalling her abroad; to get lower masts and other heavy weights in and out; how to construct rafts, and as to his resources for the preservation of the ship's crew in the event of wreck, and in such operations of a like nature as the examiner may consider necessary.

The candidates will be allowed to work out the various problems according to the method and the tables they have been accustomed to use, and will be allowed five hours to perform the work; at the expiration of which, if they have not finished, they will be declared to have failed, unless the Local Marine Board see fit to extend the time.

Applicants for examination are required to give their names to the Shipping Master, or to the Local Marine Board, at the place where they intend to be examined, on or before the day of examination, and to conform to the regulations in this respect which may be laid down by the Local Marine Board; and if this be not done, a delay will be occasioned.

The examinations will commence early in the forenoon, and be continued from day to day, until all the candidates, whose names appeared upon the Shipping Master's list on the day of examination are examined.

Testimonials of character, sobriety, and trust worthiness, will be required of all applicants, and without which no person will be examined; and as testimonials may have to be forwarded to the office of the Registrar General of Seamen in London, for verification, before any certificates can be granted, it is

desirable that candidates should lodge them as early as possible. Upon application to the Shipping Master, candidates will be supplied with a form, which they will be required to fill up and lodge with their testimonials in the hands of the Examiners.

The fee for examination must be paid to the Shipping Master. If a candidate fail in his examination, half the fee he has paid will be returned to him by the Shipping Master, on his producing a document which will be given him by the Examiner.

The following are the fees to be paid by applicants for examination:—

Second Mate	£1	0	0
First and Only Mate, if previously possessing an inferior certificate	0	10	0
If not	1	0	0
Master, whether Extra or Ordinary	2	0	0

Any one who has been one year in possession of a Master's first-class Certificate, granted by one of the former Boards of Examiners, or of any Ordinary Master's Certificate of Competency granted under the present Examiners, may pass an Extra Examination, and receive an Extra Certificate in exchange for his former one, without payment of any fee; but if he fails in his first examination, he must pay half a Master's fee on his coming a second time; and the same sum for every subsequent attempt.

If the applicant passes he will receive a document from the Examiner, which will entitle him to receive his Certificate of Competency from the Shipping Master at the port to which he has directed it to be forwarded. If his testimonials have been sent to the Registrar to be verified, they will be returned with his certificate.

If an applicant is examined for a higher rank and fails, but passes an examination of a lower grade, he may receive a Certificate accordingly, but no part of the fee will be returned.

As the examinations of Masters and Mates are made

compulsory, the qualifications have been kept as low as possible; but it must be distinctly understood, that it is the intention of the Board of Trade to raise the standard from time to time, whenever, as will no doubt be the case, the general attainments of officers in the merchant service shall render it possible to do so without inconvenience; and officers are strongly urged to employ their leisure hours, when in port, in the acquirement of the knowledge necessary to enable them to pass their examinations; and Masters will do well to permit apprentices and junior officers to attend schools of instruction, and to afford them as much time for this purpose as possible.

EXAMINATIONS IN STEAM.

Arrangements have been made for giving to those Masters, or applicants for Masters Certificates, who desire to do so, an opportunity of undergoing an examination as to their practical knowledge of the use and working of the steam engine. These examinations will be conducted under the superintendence of the Local Marine Boards, at such times as they may appoint for the purpose; and the Examiners will be selected by the Board of Trade from the engineer surveyors appointed under the Steam Navigation Act.

The examination will not comprise intricate theoretical questions, but will be such as to satisfy the Examiner that the applicant is competent to control the working of the engine, and has such a knowledge of the ordinary parts of the machinery, as will enable him to judge of the nature of an accident, and, in the absence of the engineer, to give the necessary directions in the engine room.

The practice will be as follows:—The applicant must deliver to the Shipping Master a statement in writing to the effect that he wishes to be examined in Steam. If he is about to pass a master's examination in navigation also, this statement must be on or annexed to the form E. E.; if he has a Master's

Certificate of Competency, it must be delivered to the Shipping-Master with his Certificate, so that due notice may be given to the Examiner, and so that the Board of Trade on receiving it may have the means of indorsing on his Certificate, and recording the fact that he has passed in Steam. He must also at the same time pay a fee of 7*s.*, which will be applied in remunerating the Examiners. Notice will be given of the time at which the applicant is to attend to be examined; and if he passes, the result of the examination will be reported to the Board of Trade, and his Certificate of Competency will be issued or returned to him, as the case may be, with an indorsement as above mentioned, showing that he has passed in Steam. If he fails, no notice of the failure will be reported on the Certificate, but no part of the fee will be returned.

F. W. BEECHEY.
W. H. WALKER.

T. H. FARRER,
Secretary.

Naval Department, Board of Trade,
May, 1852.

MISCELLANEOUS QUESTIONS IN ARITHMETIC.

[These are similar to those given when the Examination was first made compulsory, and are introduced here for practice.]

1. Express in figures, ten millions ten thousand and ten.
2. Add together 17984, 739, 9, 6754, 896, 97, and 7493.
3. In 97864 cables, each containing 120 fathoms, how many inches?
4. Divide 874687718592 by 9648.

5. Express in figures, nine hundred and nine thousand and forty.
6. Add together 8, 746, 84, 97631, 471, 140011 and 639.
7. In 8694 tons, how many ounces?
8. Divide 5240037752890 by 86321.

9. Express in figures, one hundred and four millions ninety thousand and nine.
10. Add together 768, 4597, 8, 460, 62, 179634 and 98.
11. In 68049 statute miles, how many barleycorns?
12. Divide 6903523318679 by 84097.

13. Express in figures, ninety millions two hundred and four thousand and fifty.
14. Add together 874, 97643, 96, 4, 371, 930872 and 15.
15. In 8076 centuries, how many seconds? 365¼ days being reckoned to the year.
16. Divide 7941037222000 by 9839.

17. Express in figures, one hundred millions sixty thousand four hundred and nine.
18. Add together 876, 4973, 64, 9, 754319 and 474.
19. In 769846 statute miles, how many inches?
20. Divide 55175168622402000 by 8609000.

21. Express in figures, nine hundred millions two thousand and one.

22. Add together 87.64, 987641, 470, 91, 9, and 8746.

23. In 6785 Great Circles, how many seconds (″)?

24. Divide 120140420490 by 60070.

25. Multiply £ 36. 17*s.* 4¾*d.* by 79.

26. If ⅛ of a ship be worth £ 207. 10*s.* 3*d.* what part can be purchased for £ 1245. 1*s.* 6*d.*

27. Required the value of a nugget of gold weighing 84 lbs. at £ 3. 12*s.* 1½*d.* per oz.

EXERCISES IN LOGARITHMS, &c.

Sufficient directions are given to all tables of logarithms in respect to the method of using them, but the following remarks are for the purpose of enforcing the necessity of having a due regard to the *characteristic* or *index* of a logarithm, the neglect of which is productive of great error.

Take any numbers as 27, 564, 3047; the first consists of two, the second of three, and the third of four *digits*. Take also any number as 765·476; the figures (765) on the left of the decimal point compose the *integral part*, those on the right (476) are *decimals*. Again take any logarithm as 3·124830, the first figure (3) is called the *index*, and the remaining portion is the *decimal part* or *mantissa*; now the mantissa of the logarithm of any number above 100 is all that is registered in the tables, and the index has therefore to be supplied. These observations being understood the following Rule must be borne in mind.

Rule. The *index* of the logarithm of a number *greater* than unity is *one less than the number of digits in the integral part*, and when the number is *less* than unity, the *index* is properly *negative*, but the *arithmetical complement* of it is sometimes used. *Examples,*

No.	Log.
3129	3·495406
312·9	2·495406
31·29	1·495406
3·129	0·495406
·3129	$\bar{1}$·495406 or 9·495406
·03129	$\bar{2}$·495406 or 8·495406
·003129	$\bar{3}$·495406 or 7·495406

It will be perceived from above that the mantissa remains unaltered so long as the numbers consist of the *same significant figures:* change the numbers and the mantissa must also change. *Examples,*

No.	Log.
2516	3·400711
303·3	2·481872
6·561	0·816970
·8407	$\bar{1}$·924641 or 9·924641

The reverse of the foregoing rule holds good in every particular, *i. e.* having sought in the the tables of logarithms for the number corresponding to the given mantissa, the *index* will determine the *number of digits in the integral part.*

Examples,

Log.	No.
3·892873	7814
2·954435	900·4
0·620968	4·178
$\bar{1}$·817631 or 9·817631	·6571
$\bar{3}$·176091 or 7·176091	·0015

Examples for Practice.

1. Required the logarithm of the following numbers,—

6754	7200	43710	39906	400000
·1463	·00647	3·874	18·006	·0046

2. Find the number corresponding to the following logarithms,- -

0·768432	0·821567	2·374900	1·610432	4·000710
1·874216	1·914000	3·100300	3·214797	5·001476

3. Find the log. sine of

47° 30′ 52″	170° 30′ 39″	1° 49′ 47″
72 4 25	110 11 18	1 0 40

Find the log co-sine of

36 7 21	88 40 56	88 59 19
20 8 40	30 0 50	108 40 6

Find the log tangent of

22 20 11	1 8 7	52 10 46
37 9 41	1 2 18	114 9 30

4 Find the log co-tangent of

38 50 19	58 43 37	71 43 6
64 10 40	9 8 39	3 7 4

Find the log secant of

20 30 15	45 10 19	71 43 6
29 11 40	101 8 7	38 7 4

Find the log co-secant of

45 8 29	70 30 24	141 16 51
127 30 40	60 11 9	16 0 20

5 Find the arc to the log. sine of

9·180641	9·990640	8·462167	8·846217

co-sine of

9·344178	9·983862	9·876419	8·967391

tangent of

9·642876	10·846215	9·846175	10·060431

co-tangent of

9·742691	10·876432	9·374611	8·460000

secant of

10·034687	10·090188	11·546718	11·200000

co-secant of

10·109761	10·061462	11·467931	11·000873

6. Multiply 4 by 75 by logs.

7. Multiply 75 by 60 by logs.

8. Multiply 701 by 9 by logs.

9. Multiply 1074 by 2 by logs.

10. Multiply 7000 by 1 by logs.
11. Multiply 476 by 682 by logs.
12. Multiply ·3746 by ·6168 by logs and decimals.
13. Find the product of 38, 1·74, 96, and ·0756, by logs
14. Find the product of 376, ·0069, and 1·476 by logs.
15. Find the product of 2·4, ·008, ·62 and 3·1.
16. Divide 66 by 3 by logs.
17. Divide 777 by 11 by logs.
18. Divide 1728 by 144 by logs.
19. Divide 1000 by 1000 by logs.
20. Divide 1010 by 101 by logs.
21. Divide 87469 by 364 by logs.
22. Divide 37 by ·02 by logs. and decimals.
23. Divide 76 by 874 by logs.
24. Divide 10 by 5·86 by logs. and decimals.
25. Divide 6748 by ·00763 by logs.
26. Divide ·34761 by 2·674 by logs and decimals.
27. Required the square of 46, of 94, of ·163 and of ·0075 by logs.
28. Required the cube of 47, of 63, of ·109 and of ·00861 by logs.
29. Required the square root of 4796, of 746937 and of ·6470, by logs.
30. Required the cube root of 36472, of 62154 and of ·7564 by logs.
31. What is the cost of 243 yards at 9*s*. 3$\frac{3}{4}$*d*. per yard, by logs and decimals.
32. What is the cost of 3 tons 2 cwt. 3 qrs. at 4*s*. 6*d*. for 7lbs. by logs.
33. If 100 yards cost £ 70. 15*s*. what does 1 foot cost at the same rate?
34. If $\frac{7}{8}$ of a lb. cost 4*s*. 8$\frac{1}{2}$*d*. what will 27$\frac{9}{10}$lbs. cost?

DAYS WORKS.

H.	K.	1/10	Courses.	Winds.	Lee Way	Remarks.
1						P.M. I take my departure from a point of land in Lat 34° 51′S. Long 20° 2′E. bearing by compass N.N.W. ½ W. distant 17 miles.
2	7	2	S.	N. by W.	0	
3	6	4				
4	7	0				
5	7	4				
6	7	0	S. by E.		0	
7	6	8				
8	7	2				
9	6	8	S.E.	N.E. by E	¼	
10	6	8				
11	7	4				
12	7	0	East.	N.N.E.	½	
1	6	8				A.M
2	7	2				
3	6	4				
4	5	6				A current sets W. by S. by compass at the rate of 2¼ miles per hour.
5	6	0	E.N.E.½E.	North.	¼	
6	6	6				
7	6	4				
8	7	0	N.N.W.	N.E.	¾	
9	6	0				
10	6	6				
11	5	4				
12	6	0				Variation 2¼ pts. W

H.	K.	1/10	Courses.	Winds.	Lee Way	Remarks.
1						P.M. I take my departure from a point of land, in Lat. 40° 29′N. Long. 124° 32′W bearing by compass E. ½ S. distant 17 miles.
2	4	6	S.W.	N. W. b. N.	0	
3	5	4				
4	6	0				
5	7	0	S.S.W.		0	
6	6	6				
7	6	4				
8	6	6	W.S.W.		¼	
9	7	4				
10	8	0				
11	7	6	N.W.	N.N.E.	½	
12	7	4				A.M.
1	8	0				
2	7	6				
3	7	4				A current set E.N.E. by compass 14 miles during the last 10 hours.
4	7	4	W.N.W.		0	
5	6	6				
6	6	4	S.E.b.E.	N.E.b.E.	½	
7	6	4				
8	5	4				
9	5	4				
10	6	4				
11	7	0			1	Variation 1¼ pts. E.
12	8	0				

DAYS WORKS.

H.	K.	1/10	Courses.	Winds.	Lee way.	Remarks.
1						P.M.
2	4	4	W. by S.	S. by W.	0	I take my departure from a point of land in Lat. 25° 39′S. Long 45° 2′E. bearing by compass N.W. by N.¼N. distant 21 miles.
3	5	6				
4	5	6	S.E. by S.	S.W. by S.	¼	
5	6	6				
6	7	6				
7	8	2				
8	7	6	S.S.E.	S.W.	1	
9	7	4				
10	6	4				
11	6	6				
12	7	0				A.M.
1	7	0	S.W. by W.	S.E.	½	
2	7	0				
3	7	0				A current set the ship S W.byS. by compass, at the rate of 4 miles an hour, during the last 8 hours.
4	7	4				
5	6	6				
6	6	0	S.S.W.½W.	E. by N.	0	
7	6	0				
8	5	5				
9	6	5				
10	6	0	N.W.½W.		0	
11	6	5				
12	7	5				Variation 2 pts. W.

H.	K.	1/10	Courses.	Winds.	Lee way	Remarks.
1						P.M. I take my departure from a point of land. bearing by compassS.W. distance 18 miles, in Lat 37°35′S. Long. 150° 5′E.
2	3	4	S.S.E.	S.W.	1	
3	3	6				
4	4	0				
5	6	2	W.N.W.		1½	
6	4	4				
7	5	4				
8	6	4				
9	4	6				
10	2	4	W by N	S.W.b.S.	2	
11	5	0				
12	4	4				
1	4	6				A.M.
2	5	6				
3	5	4	S.b.E.¾E.	S.W.	1½	
4	3	2				A current set the ship 18 miles S. by W. by compass
5	6	4				
6	7	7				
7	2	3				
8	4	5	S.S.E.	S.W.b.W.	1¾	
9	2	6				
10	6	2				
11	4	3				
12	5	4				Variation ¾ pts E.

DAYS WORKS.

H.	K.	$\frac{1}{10}$	Courses.	Winds.	Lee Way	Remarks.
1						P. M.
2	6	0	S. W.	N. by W.	0	I take my departure from a point of land
3	5	4				in Lat. 4° 24'N. Long. 7°46'W. bear-
4	6	4		N. W. b. N.		ing N.¼E. (by compass) dist. 18 miles
5	7	2				
6	7	0	W. by S.		½	
7	6	6				
8	6	4				
9	7	0				
10	8	0				
11	7	6	N. W. by W.	S. W. b. W.	1	
12	7	4				A. M.
1	6	6				
2	6	4				
3	6	2				
4	5	6				A current set the ship E. by S.½S. (by
5	5	2				compass) 15 miles in the 24 hours.
6	4	0	S. by E.		½	
7	4	6				
8	4	4				
9	5	0				
10	6	0	West.	S. S. W.	¼	
11	6	4				
12	6	6				Variation 1¾ pts. W.

H.	K.	$\frac{1}{10}$	Courses.	Winds.	Lee Way	Remarks.
1						P. M. I take my departure from a point
2						of land, in Lat. 34° 26'S. Long. 172°
3						38'E. bearing by compass E. by S.½S.
4						distant 17 miles.
5	4	2	S. S. W.	N. W.	¼	
6	3	4				
7	4	0				
8	6	4				
9	2	6	N. W. b. W.	S. E.	0	
10	6	4				
11	6	0				
12	5	8	S.b. W. ¾ W.	S. E. ¼E.	2¼	
1	6	0				A. M.
2	6	4				
3	4	8				
4	2	4	N. N. E.	N. W.	2	
5	5	5				A current set the ship the last 4 hours 2½
6	6	6				miles an hour N. W. ½W. by compass.
7	6	5				
8	4	3	N.E.	W.	¼	
9	7	4				
10	6	2				
11	4	4				
12	5	7				Variation 1½ pts E.

DAYS WORKS.

H.	K	F.	Courses.	Winds.	Lee way.	Remarks.
1	3	0	West.	S.S.W.	1	I take my departure from a point in Lat. 25° 39′ S. Long. 45° 7′ E. bearing by compass N.W. by N. distant 9 miles.
2	3	0				
3	3	0				
4	4	0	S.S.E.	S.W.	¼	
5	4	5				
6	4	5				
7	5	0	S.b.E.	S.W.b.W.	0	
8	5	5				
9	5	5				
10	6	0				
11	6	0				A current setting to S.W. by compass at the rate of 16 miles in the 24 hours.
12	6	5				
1	7	0	S. by W.	W. by S	0	A.M.
2	7	0				
3	8	0				
4	8	0				
5	8	0	North.		½	
6	8	0				
7	8	0				
8	8	0				
9	7	5				
10	7	5				
11	6	0				
12	6	5				Variation 24°W.

H.	K.	F.	Courses.	Winds.	Lee way.	Remarks.
1						I take my departure from a point in Lat. 34° 30′S. Long. 172° 49′E. bearing E. by compass, distant 17 miles.
2	6	0	W.b.N.	N.	0	
3	6	4				
4	6	6				
5	7	0				
6	8	0			¼	
7	7	6	S. W. ½W.	N.W.b.W.	½	
8	7	4				
9	8	0				
10	8	6			¼	
11	8	4				
12	8	0	S. S. W.	W.	0	
1	7	6				A.M.
2	7	4				
3	8	0	W. S. W.	S. by E.	0	A current sets to N. by compass at the rate of 10 miles in 24 hours.
4	8	0				
5	7	6				
6	7	4				
7	6	0				
8	6	6			¼	
9	6	4				
10	5	6				
11	5	4				
12	5	0				Variation 15° E.

ON TIME.

Time being a measured portion of infinite duration, any event which recurs at equal intervals might be taken as the unit of admeasurement, and to this end, nothing seems more appropriate than that the required standard should be sought among the innumerable celestial orbs, which appear to be continually revolving around our Earth.

Numberless observations, made in different ages of the world, have proved that the time intervening between two consecutive passages of the same star over a given meridian, is uniform and unchanging. Here then, we have a standard more exact than any that could be devised by art. Owing, however, to the elipticity of the earth's orbit, and the plane of the equator not being coincident with that of the ecliptic, this measure of time, (called by astronomers the sidereal day,) which is wholly uninfluenced by such phenomena, does not agree with the interval measured by the apparent revolution of the Sun around our earth; and since, if it had been adopted as the unit of admeasurement, the day (by which term is understood a certain fixed and uniform period of time,) would have commenced at no regular instant, as regards the rising, setting, or meridian transit of *that* luminary, which is at once the centre of our system and the source of light and heat; it seems therefore not only more natural, but certainly more convenient for the ordinary purposes of life, that the "working day" should be regulated by the Sun.

Now the *true solar*, or *apparent* day, which is measured by two successive passages of the sun over the meridian of any place on the earth's surface, is a variable quantity; but

there is a regular succession of its variations, which in a certain period, termed a year, come to an end, to be commenced anew. In order, therefore, to obtain a convenient and equable measure of time, astronomers assume a *mean solar day*, the length of which is equal to the average of all the apparent solar days in the year.

The interval by which the apparent is in excess or falls short of the mean day, constitutes the *equation of time;* this difference is greatest about the 3rd of November, and four times in a year viz. April 15, June 15, September 15, and December 24, it vanishes, or is exceedingly small.

We next notice two methods of *commencing* the day, which unless fully understood, must be productive of very considerable error in working the various questions which arise in Nautical Astronomy.

1. The *astronomical day* begins at *noon*, and its minor divisions are reckoned from that instant, or $0^h\ 0^m\ 0^s$ to 24^h, continuously.

2. The *civil day*, which is the one used in reference to the ordinary transactions of life, commences at *midnight* and *precedes* the astronomical day by 12 hours, but its minor divisions are *not* counted *successively* to 24 hours; the interval from midnight to noon being styled A.M., and that from noon to midnight again P.M., each reckoned to 12 hours.

The distinction between the astronomical and civil day being clearly understood, it will at once be evident that from noon to midnight, the day of the month and the hour of the day are the same in both methods of reckoning; but from midnight to noon they differ; in illustration, turn to the Nautical Almanac for the year 1854, page 564; at the top of the first column, under January, is found $1^d\ 2^h\ 7^m$ ☉ in perigee; this is in astronomical time, and coincides with January 1*st*, $2^h\ 7^m$ P.M. civil time. The next phenomenon

on the same page is marked thus, in astronomical time, $1^d\ 23^h\ 53^m$ ♀ ☌ ☾, which expressed in civil time would be January *2nd*, $11^h\ 53^m$ A.M. So in like manner, a morning observation of a celestial object made under any meridian, say March 20, (civil time) at $8^h\ 40^m$ A.M. would be represented astronomically thus, March $19^d\ 20^h\ 40^m$; while another observation made on the same day, but in the evening, as thus, March 20 (civil time) at $4^h\ 20^m$ P.M. is expressed in astronomical time, March $20^d\ 4^h\ 20^m$; and the application of the longitude in time, (by addition if westerly, by subtraction if easterly,) to the given or estimated time of observation, will be the corresponding Greenwich time.

Since all the elements of the heavenly bodies given in the Nautical Almanac bear reference to the *astronomical day,* its relation to the civil mode of reckoning must never be lost sight of; for unless the true *Greenwich astronomical date* be known at the time an observation is made to determine latitude, longitude, or variation of the compass, &c. it is impossible that the solution of the question can be correct.

The sidereal day, to which we have already referred, consists of $23^h\ 56^m\ 4{\cdot}09^s$ mean solar time. In the determination of certain elements by means of a Planet, the Moon, or a Fixed Star, the operation is somewhat shortened by a knowledge of sidereal time.

We have made these remarks solely to impress on Navigators the importance of making themselves perfectly acquainted with *time,* which can be done by a careful perusal of the "Epitomes," and it cannot be too strongly urged that it is also especially desirable that every one using the Nautical Almanac should make himself thoroughly acquainted with its contents, to accomplish which it is necessary to peruse *very carefully* the "Explanations" at the end of that book.

Paper I.

For Second Mate.

1. Multiply 76 by 43 by logarithms.

2. Divide 144 by 4 by logarithms.

3. In latitude 33°, the departure made was 130m.: required the difference of longitude by parallel sailing.

4. March 20, 1854; long. 168° 45′W.; the observed meridian altitude ☉ 62° 10′ 40″; sun S. of observer; index error —1′ 50″; eye 18 feet: required the latitude.

Additional for Only Mate.

5. Compute the course and distance by Mercator's sailing, from Cape Voltas, lat. 28° 44′S., long. 16° 32′E.; to Charleston, lat. 32° 41′N. long. 79° 53′W.

6. Jan. 6, 1854; at $6^h\ 25^m\ 32^s$ A.M. apparent time at ship; lat. 15° 30′N.; long. 107° 37′W.; the sun's rising amplitude was observed by compass to be E. 18° 20′S.; required the variation.

7. Jan. 6, 1854; required the A.M. and P.M. tides at Shields.

Additional for Chief Mate.

8. Jan. 6, 1854, at $3^h\ 40^m\ 16^s$ P.M. mean time at ship: lat. 52° 45′S.; long. 66° 56′W.; the observed altitude ☉ 38° 31′ 40″; eye, 20 feet; sun's bearing by azimuth compass, S. 82° 50′W.; required the variation.

9. Jan. 6, 1854, P.M. at ship; lat. 4° 30′N.; the observed altitude ☉ 30° 10′ 45″; index error —1′ 9″; eye, 21 feet; time by chronometer, $5^d\ 18^h\ 59^m\ 59^s$, which had been found $7^m\ 52^s$ fast on mean time at Greenwich, Oct. 17, 1853, and losing 4^s daily; determine the longitude.

10. Jan. 6, 1854, P.M. at ship; lat. by account 61° 45′S.; long. 138° 8′E.; the observed altitude ☉ near the meridian, 50° 4′ 40″; observer S. of the sun; eye, 19 feet; time by watch, $5^d\ 23^h\ 59^m\ 50^s$ which had been found $38^m\ 46^s$ slow on apparent time at ship; but the ship had made 16′ diff. long. to W. since the error for apparent time had been ascertained; required the true latitude.

Additional for Master Ordinary.

11. Correct the following courses for the local attraction, as given at page 35, N.E.—E. by S.—S.S.W.—N. by W.—E.N.E.

12. Jan. 14, 1854; long. 20°W.; the observed meridian altitude of Sirius, (α Canis majoris,) being 37° 50′ 20″; observer N. of the star; index error, + 1′ 4″; eye 19 feet; required the latitude.

Paper II.

For Second Mate.

1. Multiply 109 by 47 by logarithms.

2. Divide 786 by 393 by logarithms.

3. In latitude 44°, the departure made was 95m.; required the difference of longitude by parallel sailing.

4. March 20, 1854: long. 155°W.: the observed meridian altitude $\underline{\odot}$ 50° 10′ 40″: sun N. of observer: index error —1′ 19″: eye, 18 feet: determine the latitude.

Additional for Only Mate.

5. Compute by Mercator's sailing, the course and distance from Point de Galle, lat. 6° 1′N,: long. 80° 14′E.: to Zanzibar S. Point, lat. 6° 10′S.: long. 39° 15′E.

6. March 31, 1854, at $6^h\ 2^m$ P.M. apparent time at ship: lat. 6° 25′N.: long. 156°E.: the sun's setting amplitude was observed by compass W. 3° 40′S.: determine the variation.

7. Required the A.M. and P.M. tides at the Nore Light, on March 6, 1854.

Additional for Chief Mate.

8. March 26, 1854, at $9^h\ 0^m$ A.M. mean time at ship, lat. 43° 10′N.: long 52° 30′W.: the observed altitude $\underline{\odot}$ 32° 36′ 45″, bearing by azimuth compass S. 40° 30′E.: eye, 18 feet: required the variation.

9. March 28, 1854, P.M. at ship: lat. 20° 9′S.: observed altitude $\underline{\odot}$ 30° 10′ 20″: eye, 26 feet: time by chronometer, $28^d\ 0^h\ 4^m\ 50^s$, which had been found $46^m\ 46^s$ fast on mean time at Greenwich, Nov. 29, 1853, and losing 4^s daily: required the longitude.

10. March 5, 1854, A.M. at ship; lat. by account 33° 40′N.: long. 20° 1′W.: observed altitude $\underline{\odot}$ near the meridian 49° 50′: observer N. of sun: eye 22 feet: time by watch $5^d\ 1^h\ 0^m\ 30^s$: the watch had been found $1^h\ 21^m\ 14^s$ fast on apparent time at ship, but the ship had made 10′ diff. long. to E. since the error for apparent time had been determined: required the true latitude.

Additional for Master Ordinary.

11. Correct the following courses for local attraction, as given at page 35, East.—E.S.E.—N.N.W.—W.S.W.

12. July 1, 1854: long. 87°E.: the observed meridian altitude of Antares, (*a* Scorpii) being 68° 45′ 30″: star N. of observer: eye 21 *feet*: required the latitude.

Paper III.

For Second Mate.

1. Multiply 3009 by 4 by logarithms.

2. Divide 9460 by 86 by logarithms.

3. In latitude 50°, the departure made was 63m.: required the difference of longitude by parallel sailing.

4. April 6, 1854: long. 78°45′E.: the observed meridian altitude ⊙ 47° 50′ 15″: observer S. of the sun: index error —1′ 20″: eye 19 feet: required the latitude.

Additional for Only Mate.

5. Compute by Mercator's sailing, the course and distance from Angra Pequena, lat. 26° 38′S.: long. 15° 8′E.: to Cape St. Roque, lat. 5° 28′S.: long. 35° 17′W.

6. April 29, 1854, at 5^h 32^m A.M. apparent time at ship: lat. 25° 11′N.: long. 136°W.: the sun's rising amplitude was observed to be E. 24° 15′N.: required the variation.

7. April 4, 1854: required the A.M. and P.M. tides at Torbay.

Additional for Chief Mate.

8. April 25, 1854, at 2^h 42^m 10^s P.M. mean time at ship: lat. 48° 42′S.: long. 50° 40′E.: the observed altitude ⊙ 18° 21′: bearing by compass N. 7° 10′W.: eye 19 feet: required the variation.

9. April 15, 1854, A.M. at ship: lat. 41° 1′N.: observed altitude ⊙ 35° 40′: eye 20 feet: time by chronometer 15^d 6^h 0^m 40^s, which had been found 2^m $1{\cdot}4^s$ fast on mean time at Greenwich, Jan. 25, and losing $5{\cdot}5^s$ daily: required the longitude.

10. April 21 1854, A.M. at ship: lat. by account 39° 53′N.: long. 6° 5′E.: the observed altitude ⊙ near the meridian 61° 27′ 35″: sun S. of observer: eye 18 feet: time by watch 21^d 0^h 1^m 50^s. which was found 20^m 50^s fast on apparent time at ship, but the ship had made 5′ diff. long. to E. since the error for apparent time had been determined: required the true latitude.

Additional for Master Ordinary.

11. Correct the following courses for local attraction, as given at page 35, S.W.—N.W.—W.N.W.—South.

12. Dec. 3, 1854: long. 175°E.: the observed meridian altitude of *a* Arietis being 46° 20′: star N. of observer: eye 20 feet: required the latitude.

Paper IV.

For Second Mate.

1. Multiply 200·6 by 7 by logarithms.

2. Divide 16·04 by 4·4 by logarithms.

3. In latitude 57°, the departure made was 91m.: required the difference of longitude by parallel sailing.

4. Sept. 23, 1854: long. 166° 30′E.: the observed meridian altitude $\underline{\odot}$ 41° 30′: sun N. of observer: index error +1′ 19″: eye 17 feet: required the latitude.

Additional for Only Mate.

5. Required the course and distance by Mercator's sailing, from Port Jackson, lat. 33° 51′S: long. 151° 18′E.: to Acapulco, lat. 16° 51′N.: long. 99° 52′W.

6. July 28, 1854, at $7^h\ 27^m\ 30^s$ A.M. apparent time at ship: lat. 47° 8′S.: long. 84° 15′W.: the sun's rising amplitude was observed by compass E. 42° 40′N.: required the variation.

7. Required the A.M. and P.M. tides, July 21, at Whitby.

Additional for Chief Mate.

8 July 31, 1854, at $8^h\ 46^m\ 30^s$ A.M. mean time at ship: lat. 38° 18′N.: long. 65°W.: the observed altitude $\underline{\odot}$ 43° 26′ 10″: bearing S. 78° 20′E.: index error —1′ 12″: eye 19 feet: required the variation.

9. July 29, 1854, A.M. at ship: lat. 40° 10′S.: the observed altitude $\underline{\odot}$ 17° 10′ 40″: eye 24 feet: time by chronometer $28^d\ 22^h\ 10^m\ 40^s$, which was $9^m\ 45{\cdot}5^s$ fast on mean time at Greenwich, June 8, and losing 6^s daily: required the longitude.

10. July 10, 1854, A.M. at ship: lat. by account 51° 43′N.: long. 30° 10′W.: observed altitude $\underline{\odot}$ near the meridian 59° 47′: observer N. of the sun: index error —1′ 13″: eye 18 feet: time by watch $10^d\ 2^h\ 10^m$, which had been found $2^h\ 40^m$ fast on apparent time at ship, but the ship had made 10′ diff. long. to W. since the error for apparent time had been ascertained: required the true latitude.

Additional for Master Ordinary.

11. Correct the following courses for local attraction, as given at page 35, West.—N.E. by E.—S.W. by W.—E.N.E.

12. July 21, 1854: long. 18° 45′E.: the observed meridian altitude of the planet Jupiter being 69° 40′ 10″: observer S. of the planet: eye 21 feet: required the latitude.

Paper V.

For Second Mate.

1. Multiply 7·64 by 1·6 by logarithms.

2. Divide 34·76 by 1·2 by logarithms.

3. In latitude 40°, the departure made was 108m.: required the difference of longitude by parallel sailing.

4. Sept. 23, 1854; long. 90° 45′E.: the observed meridian altitude ☉ 83° 40′ 30″: observer N. of the sun: eye 18 feet: required the latitude.

Additional for Only Mate.

5. Required the course and distance by Mercator's sailing, from Cape Hatteras, lat. 35° 14′N.: long. 75° 30′W.: to Cape Frio, lat. 18° 23′S.: long. 12° 2′E.

6. Oct. 1, 1854, at 6^h 13^m A.M. apparent time at ship: latitude 47° 10′N.: long. 15° 30′W.: the sun's amplitude at rising was observed E. 31°S.: required the variation.

7. Sept. 16, 1854: required the A.M. and P.M. tides at Brest Harbour.

Additional for Chief Mate.

8. Sept. 2, 1854, at 3^h P.M. mean time at ship: lat. 39° 30′S.: long. 37° 30′E.: the observed altitude ☉ 26° 40′ 35″: eye 18 feet: sun's bearing by azimuth compass N. 21° 10′W.: required the variation.

9. Sept. 1, 1854, P.M. at ship: lat. 2° 10′N.: the observed altitude ☉ 28° 40′: index error —47″: eye 22 feet: time by chronometer August 31^d 23^h 58^m 49^s, which had been found 15^m 26^s slow on mean time at Greenwich June 23rd, and losing $4{\cdot}5^s$ daily: required the longitude.

10. Sept. 16, 1854, A.M. at ship: lat. by account 42° 36′S.: long 137° 10′E.: the observed altitude ☉ near the meridian 44° 10′ 30″: sun N. of observer: index error —2′ 20″: eye 19 feet: time by watch 16^d 0^h 2^m 46^s, which had been determined 23^m 10^s fast on apparent time at ship, but the ship had made 14′ diff. long. to W. since the error for apparent time had been ascertained; required the true latitude.

Additional for Master Ordinary.

11. Correct the following courses for local attraction, as given at page 35, W. by S.—S. by W.—E. by S. ½ S.—N.W. ½ W.

12. August 1, 1854: long. 36° 15′W.: the observed meridian altitude of the planet Jupiter being 60° 30′ 40″: planet S. of observer: index error + 1° 11″: eye 18 feet; find the latitude.

Paper VI.

For Second Mate.

1. Multiply 706 by 9 by logarithms.

2. Divide 1728 by 144 by logarithms.

3. In latitude 54°, the departure made was 60m.; required the difference of longitude by parallel sailing.

4. Sept, 23, 1854; long. 80° 15′E.; the observed meridian altitude ☉ 57° 20′ 30″; observer S. of the sun; index error +1′ 20″; eye 21 feet; required the latitude.

Additional For Only Mate.

5. Determine by Mercator's sailing, the course and distance from Halifax, lat. 44° 39′N.; long. 63° 37′W; to Cape Town, lat 33° 56′S.; long. 18° 28′E.

6. Dec. 16, 1854, at $7^h\ 24^m\ 28^s$ P.M. apparent time at ship; lat. 40° 4′S.; long. 126° 7′E.; the sun's setting amplitude was observed to be W. 27° 30′ 30″S.; required the variation of the compass.

7. Dec. 16, 1854; required the A.M. and P.M. tides at Shields.

Additional for Chief Mate.

8. Dec. 16, 1854, at $8^h\ 2^m$ A.M. mean time at ship; latitude 48° 58′S.; long. 149° 30′W.; the observed altitude ☉ 37° 4′ 30″; bearing by azimuth compass N. 74° 0′E.; index error 0″; eye 17 feet; determine the variation of the compass.

9. Dec. 15, 1854, A.M. at ship; lat. 30° 49′N.; the observed altitude ☉ 17° 49′ 0″; index error +34″; eye 18 feet; time by chronometer $15^d\ 5^h\ 40^m\ 44^s$, which had been found $46^m\ 10^s$ slow on mean time at Greenwich July 13, and was gaining $4{\cdot}6^s$ daily; determine the longitude.

10. Dec. 16, 1854, A.M. at ship; lat. by account 33° 48′N.; long. 25° 19′E.; the observed altitude ☉ near the meridian 32° 30′ 40″S.; index error +22″; eye 17 feet; time by watch $16^d\ 0^h\ 2^m\ 54^s$, which had been found $22^m\ 22^s$ fast on apparent time at ship, but the ship had made 11′ diff. of long. to the E. since the error for apparent time had been determined; required the true latitude.

Additional for Master Ordinary

11. Correct the following courses for local attraction, as given at page 35, E. ½ S.—N.E. ½ E.—N. by E. ½ E —N.N.W·

12. Dec. 16, 1854; long. 147°W.; the observed meridian altitude of Aldebaran, (α Tauri) being 50° 13′ 13′; the zenith N. of the star; index error —1′ 17″; eye 18 feet; required the latitude.

LOCAL ATTRACTION.

DEVIATION OF THE COMPASS.

Local Attraction is a term used to denote the influence of iron in disturbing the direction of the magnetic needle, whereby according to the extent and position of that metal in respect to the compass, a greater or less amount of *deviation from the magnetic meridian* is the result. This derangement of the compass, some 30 years ago scarcely noticed, must have been the source of numberless accidents to vessels, often accompanied by a great sacrifice of human life; for since that period, the careful researches of scientific observers have proved that it would be extremely hazardous to allow the ships of H. M. navy, steamers, or iron-built vessels to proceed to sea, without the amount of errors arising from the local attraction being previously determined; it may suffice to mention, in illustration, that in some screw-steamers the deviation with the ships's head South has amounted in the binnacle to more than fifteen points.

It must not be supposed that the compasses on board merchant vessels, are wholly free from the effect of local attraction: under ordinary circumstances, with no undue proportion of iron in the ship, the deviation may not be so great as to produce any serious error on the courses made, but the case is materially altered when the cargo consists in part, or wholly, of iron; or in fact, when any quantity of that metal is placed in the vicinity of the binnacle.

The amount of deviation on a given point of the compass is by no means a constant quantity, but it differs in different

vessels, each having a local attraction peculiarly its own: it also varies with change of position on the globe; in north magnetic latitude the north pole is attracted, in south magnetic latitude, the south pole,—increasing or decreasing as the dip of the needle increases or decreases: nor is it by any means the same in all parts of the same ship, and it may even alter from circumstances connected with the vessel itself, or the needle,—or even both. It is therefore necessary that masters should be able to ascertain, as well as know how to apply, the errors arising from the local magnetic disturbance: for this purpose two methods may be adopted,—the first being the most approved.

Method 1.— *With Two Compasses.*—The ship must be placed in such a position that she may be gradually swung, and the two compasses being compared together to note their agreement, let one of them be placed in the binnacle in its usual position, and the other taken on shore beyond the influence of the attractive force; adopt such means that a good bearing of each may be taken, and as the ship's head is brought to each point in sucession of the compass on board, at that instant let observations be made, thus,—the person on shore must take the bearing of the compass in the binnacle, and the person on board must take the bearing of the compass on shore, proceeding in this manner through the 32 points; these bearings must be tabulated after the following method:—

Direction of Ship's Head.	Bearing of Shore Compass, from Compass on Board.	Bearing of Compass on Board, from Shore Compass.	Difference of bearings, or Deviation.

The difference between the bearings will be the amount of deviation due to the local attraction of the ship, and is named *East*, when the north point of the needle is drawn to the east-

ward or right hand,—*West,* when it is drawn to the westward or left hand; and must be applied to the ship's courses in the same manner as the variation of the compass.

Method 2.—*With One Compass.*—Having determined the true bearing of a conveniently distant object, let the ship be carefully swung to each point of the compass, and on each occassion let the bearing of the object be taken; the difference between the true and observed bearing will be the error of the compass, to be named and applied as in the former case.

From the annexed table correct the courses given in the previous papers.

Direction of Ship's Head.	Deviation of Compass.	Direction of Ship's Head.	Deviation of Compass.
N.	2° 45′E.	S.	3 0 W.
N. by E.	4 57	S. by W.	4 20
N.N.E.	7 30	S.S.W.	5 0
N.E. by N.	9 0	S.W. by S.	6 7
N.E.	10 0	S.W.	7 0
N.E. by E.	10 55	S.W. by W.	7 27
E N.E.	10 40	W.S.W.	7 50
E. by N.	9 55	W. by S.	8 20
E.	8 50	W.	8 50
E. by S.	7 15	W. by N.	8 10
E.S.E.	5 35	W.N.W.	6 50
S.E. by E.	3 40	N.W. by W.	5 40
S.E.	1 50	N.W.	4 50
S.E. by S.	0 20 E.	N.W. by N.	3 20
S.S.E.	0 56 W.	N.N.W.	1 40 W.
S. by E.	2 20	N. by W.	1 10 E.

THE ADJUSTMENTS OF THE SEXTANT.

1.—*The Index Glass should be perpendicular to the plane of the Instrument.* To determine if it be so, bring the vernier to the middle of the arc, and with the limb turned from the observer, look obliquely into the mirror, then if the reflected and true arcs appear as one continued arc of a circle, the index glass is in perfect adjustment.

2.—*The Horizon Glass should be perpendicular to the plane of the Instrument.* With 0 on the vernier coinciding with 0 on the arc, hold the sextant horizontally, and looking at the horizon, observe if the reflected and true horizons are in one line: or, the instrument being held perpendicularly, look at any convenient object, as the sun, sweep the index glass, along the limb, and if the reflected image pass exactly over the direct image without any lateral projection, the horizon glass is perpendicular.

3.—*The Horizon Glass should be parallel with the Index Glass, when* 0 *on the vernier exactly coincides with* 0 *on the arc.* To ascertain this, hold the instrument vertically, and direct the sight through the telescope or sight vane, to the horizon, and if the reflected and true horizons form one continuous line, the horizon glass is parallel with the index glass.

4.—*To adjust the Line of Collimation,* or to set the axis of the telescope parallel to the plane of the sextant. Fix the telescope in its place, taking care that two wires are parallel with the plane of the instrument; select two objects, as the sun and moon, or moon and star, which are more than 90° distant from each other, bring them into contact on the wire nearest to the instrument; then by slightly moving the sextant, see how they appear on the other wire; if they are still in contact, the *Line of Collimation is in adjustment;* but if the bodies

separate when brought to the far wire, the object end of the telescope *inclines towards* the plane of the sextant; if they overlap, it *declines from* the plane.

5.—*To determine the Index error,* measure the sun's diameter on the arc of the instrument, and on the arc of excess, which is done by holding the sextant perpendicularly, and bringing the true and reflected suns in exact contact on each side of 0; *half the difference of the two readings* will be the index error, which is additive when the reading on the arc of excess is the greater, but substractive when the reading on the arc of excess is the less of the two.

MERCATOR'S CHART.

Mercator's Chart which has been compared to a cylinder unrolled, is a convenient and ingenious method of representing the surface of the globe as if it were a plane. The lines drawn from the top (North) to the bottom (South) of the chart are meridians; those from left (West) to right (East) are parallels: the top and bottom are graduated parallels; the extreme right and left are graduated meridians. The latitude of any place is measured on a graduated meridian and its longitude on a graduated parallel.

To find the course between two places, which is represented on this chart by a straight line, lay the edge of a parallel rule on the places, then slide it down until it comes exactly on the centre of one of the compasses, and the course can be read off.

To find the distance between two places, one general rule will apply:—Take *half* the distance between them; the point midway between the two places indicates the latitude to which one leg of the compasses is to be referred on the graduated meridian; carrying the other leg first North and then South

of that latitude, the degrees and minutes intercepted between the extreme points will be the *approximate* distance when the two places are on the same parallel or when they lie obliquely, and the *true* distance when they are on the same meridian.

It must be remembered that when the *true* course between two places is known, *Easterly* variation allowed to the *left* and *Westerly* variation to the *right* of this, will give the *compass* course.

To ensure accuracy in determining the place of a ship by cross bearings, the difference of the bearings should be as near as possible 90°.

THE LOG-LINE.

The speed of a vessel is ascertained by means of the Log-line and a sand glass running a given number of seconds. To determine the length of a knot on the log-line, we have the following rule: The length of the knot (in feet), must bear the same proportion to a geographical mile (in feet,) that the seconds of the glass used at the time of heaving the log, bear to the seconds contained in an hour; from which it follows that the number of knots and parts of an knot run during the interval indicated by the glass, will give the number of miles and parts of a mile the ship has sailed in an hour, supposing the rate of sailing to be uniform.

The geographical mile being about 6080 feet, we have for glasses running 28^s and 30^s respectively, the following proportions:

$3600^s : 28^s :: 6080$ ft. $: 47{\cdot}288$ft.$=47$ ft. $3\frac{1}{2}$ in.

$3600 : 30 :: 6080$ ft. $: 50{\cdot}666$ft.$=50$ ft. 8in.

the required lengths of the knot, but if 80 feet be rejected from the geographical mile, and the first and third terms of the proportion reduced, by dividing them by 600, the statements become

$6^s : 28^s :: 10$ ft. $: 46{\cdot}66$ ft.$=46$ ft. 8 in. nearly

$6^s : 30^s :: 10$ ft. $: 50$ ft.

hence the method very commonly adopted to ascertain the length of the knot: viz. annex a cipher to the number of seconds run by the glass, and divide this by 6.

The log-line must always have a sufficient quantity of what is termed "stray line," in excess of the admeasured portion, in order to allow the log to get clear of the eddy of the ship's wake; this must be determined by the size of the vessel.

It is recommended to divide the knot to tenths.

THE LEAD LINE.

In nautical phrase, the Lead Line has "nine marks and eleven deeps:"—

At 2 fathoms the mark is	Leather,
3	Leather,
5	White Rag,
7	Red Rag,
10	Leather with a round hole in it
13	Blue Rag,
15	White Rag,
17	Red Rag,
20	A piece of cord with two knots.

The Deep Sea Lead Line is marked in a similar manner to the 20 fathoms, after which a piece of cord with an additional knot for every 10 fathoms is fixed in the line, and between the tens a piece of leather to denote five fathoms.

STEAMER'S LIGHTS.

The Act of Parliament passed in the 10th year of the reign of Her present Majesty, entitled an "Act for the Regulation of Steam Navigation," requires that ***all British Steam Vessels*** whether (propelled by paddles or screws) shall, *between sunset and sunrise,* exhibit the following lights:—

When under Steam, or Sail.

A Bright White Light at the Foremast-Head.

A Green Light on the Starboard Side.

A Red Light on the Port Side.

The Mast-Head Light is to be visible at a distance of at least five miles, in a dark night, with a clear atmosphere, and the *Lantern* is to be so constructed as to show an uniform and unbroken light over an arc of the horizon of 20 points of the compass being 10 points on each side of the ship, i. e. from right ahead to 2 points abaft the beam on either side.

Each Side Light is to be visible at the distance of at least 2 miles, in a dark night, with a clear atmosphere; the lantern of each is to be so constructed as to show an uniform and unbroken light, over an arc of the horizon of 10 points of the compass, but being fitted with an inboard screen, of at least three feet long, the light cannot be seen across the bows;

hence it follows, the Green Light may be seen from right ahead to 2 points abaft the beam on the starboard side; and the Red Light from right ahead to 2 points abaft the beam on the port side.

When at Anchor, a common Bright Light is to be exhibited, the lantern of which is constructed to shew a good light all round the horizon.

LIGHTS FOR SAILING VESSELS.

Sailing Vessels when at anchor in Roadsteads or Fairways must exhibit a *bright light* at the mast head.

Sailing Vessels when under sail, or being towed, approaching or being approached by any other vessel must show between sunset and sunrise a *bright light* in such a position as can be best seen by such vessel or vessels, and in sufficient time to avoid collision.

THE RULE OF THE ROAD.

1. Sailing Vessels having the wind fair, give way to those on a wind.

2. Vessels close hauled on the starboard tack, always keep their wind.

3. Vessels close hauled on the port tack, must give way to those on the starboard tack.

N.B.—Steamers are considered as vessels with a fair wind.

LLOYD'S RULES

FOR THE

STOWAGE OF MIXED CARGOES,

Prepared by HENRY C. CHAPMAN & Co.
Agents for Lloyd's, Liverpool.

1. Owners, Commanders, and Mates of ships, are considered in law in the same situation as common carriers, it is therefore necessary that all due precautions be taken to receive and stow cargoes in good order, and deliver the same in like good order. The law holds the ship-owner liable for the safe custody of the goods when properly and legally received on board in good order, and for the "delivery" to parties producing the bill of lading. The captain's blank bill of lading should be receipted by the warehouse keeper, or person authorised to receive the contents. Goods are not unfrequently sent alongside in a damaged state, and letters of indemnity given to the captain by the shippers for signing in good order and condition; this is nothing more or less than conniving at fraud; fine Goods are also often damaged in the ship's hold by lumpers, if permitted to use cotton hooks in handling bales. All goods must be received on board according to the custom of the port where the cargo is to be taken in; and the same custom will regulate the commencement of the responsibility of the master and owners.

2.—Hemp, Flax, Wool, and Cotton, should be dunnaged 9 inches on the floors, and to the *upper part* of the bilge, the wing bales of the second tier kept 6 inches off the side at the lower corner, and 2½ inches at the sides. Sand or damp gravel ballast to be covered with boards. Pumps to be frequently sounded and attended to. *Sharp bottomed ships one-third less dunnage in floor and bilges.* Avoid Horn Shavings as dunnage from Calcutta.

3.—All Corn, Wheat, Rice, Peas, Beans, &c. when in bulk, to be stowed on a good high platform, or dunnage wood, of not less than 10 inches, and in the bilge 14 inches dunnage; the pumps and masts cased, to have strong bulkheads, good shifting boards, with feeders and ventilators, and to have no admixture of other goods Flat-floored, wall-sided ships should be fitted with bilge pumps. On no consideration must the staunchion under the beams be removed.

4.—Oil, Wine, Spirits, Beer, Molasses, Tar, &c. to be stowed bung up; to have good *cross beds* at the quarters, (*and not to trust to hanging beds*,) to be well chocked with wood, and allowed to stow three heights of pipes or butts, four heights of puncheons, and six heights of hogsheads or half-puncheons. All Moist Goods and Liquids, such as Salted Hides, Bales of Bacon, Butter, Lard, Grease, Castor Oil, &c. should not be stowed too near "Dry Goods," whose nature is to absorb moisture. Ship-owners have often to pay heavy damages for leakage in casks of Molasses, arising from stowing too many heights without an intervening platform or 'twixt decks. From Bengal, goods also are frequently damaged by Castor Oil.

5.—Tea and Flour, in barrels; Flax, Clover and Linseed, or Rice, in tierces; Coffee and Cocoa, in bags, should always have 9 inches, at least, of good dunnage in the bottom, and 14 to the upper part of the bilges, with 2½ inches at the sides: allowed to stow six heights of tierces, and eight heights of barrels. All ships above 600 tons should have 'twixt decks or platforms laid for these cargoes to ease the pressure—caulked 'twixt decks should have scuppers in the sides, and 2½ inches of dunnage laid athwart ship, and not fore-and-aft ways, when in bags or sacks: and when in boxes or casks not less than 1 inch. Rice, from Calcutta is not unfrequently damaged by Indigo, for want of care in stowing.

6.—Entire cargoes of SUGAR, SALTPETRE, and GUANO, in bags, must have the dunnage carefully attended to, as laid down for other goods. TIMBER ships are better without 'twixt decks if loading all Timber or Deals. Brown Sugar to be kept separate from white Sugar, and both kept from direct contact with Saltpetre.

7.—Pot and Pearl ASHES, TOBACCO, BARK, INDIGO, MADDERS, GUM, &c. whether in casks, cases or bales, to be dunnaged in the bottom, and to the upper part of the bilges, at *least* 9 inches, and 2½ inches at the sides.

8.—MISCELLANEOUS GOODS, such as boxes of CHEESE, kegs and tubs of LARD, or other small or slight-made packages, not intended for broken stowage should be stowed by themselves, and dunnaged as other goods.

9.—Barrels of PROVISIONS, and TALLOW casks, allowed to stow six heights. All METALS should be stowed under, and separated from, goods liable to be damaged by contact.

10.—All MANUFACTURED GOODS, also DRY HIDES, bales of SILK, or other valuable articles, should have 2½ inches of dunnage against the side, to preserve a water-course. Bundles of SHEET IRON, RODS, PIGS of COPPER or IRON, or any rough hard substance, should not be allowed to come in contact with bales or bags, or any soft packages liable to be chafed. When Mats can be procured, they should be used at the sides for Silk, Tea, &c.

11.—TAR, TURPENTINE, ROSIN, &c, to have flat beds of wood under the quarters, of an inch thick, and allowed to stow six heights.

12.—Very frêquent and serious loss falls on Merchants on the upper part of cargoes, particularly in vessels that bring Wheat, Corn, Tobacco, Oil Cake, &c. arising from vapour damage imbibed by Wheat, Flour, or other goods, stowed in the same vessel with Turpentine, or other strong-scented

articles: the shippers are to blame for such negligence, for not making due enquiry before shipping.

13.—Ships laden with full cargoes of Coal, bound round Cape Horn or Cape of Good Hope, to be provided with approved ventilators, as a preventive against ignition.

14.—No vessel bound on any over-sea voyage, should on any account be loaded beyond that point of immersion which will present a clear side out of water, when upright, of three inches to every foot depth of hold, measured amidships, from the height of the deck at the side, to the water.

Note.—Shippers abroad, when they know that their cargoes will be stowed properly, will give a preference, and at higher rates, to such commanders of ships as will undertake to guarantee the dunnage. The American ship-owners, in the stowage of mixed cargoes in large ships, have, from experience, discovered what "pressure" flour barrels, provision casks, &c. will bear, and so avoid reclamations for damage if otherwise properly stowed: hence, in large ships above 600 tons, with dimensions exceeding in length 4½ times the beam, and 21 feet depth of hold, orlop decks will come into general use, so as to relieve the pressure, by dividing a ships's hold, like a warehouse, into stories. A large ship, called the Liverpool, which left New York with an entire cargo of flour, has never since been heard of; it is supposed the lower tiers of barrels gave way under the pressure, and the cargo having got loose, shifted in a gale of wind, and capsized the vessel.

Ships' cargoes, for Insurance, will also become a matter of special agreement between merchant and ship-owner, and merchant underwriters, and the premium vary according to the dunnage agreement. The stowage and dunnage must stand A 1, and is often of more importance than the class of the vessel, as experience has proved. When ships are char-

tered for a lump sum, the draft of water should be limited, as it not unfrequently happens that brokers insert a clause that coals are not to be considered as dead weight, in order to fill the ship up in case of goods falling short to make up the chartered freight.

All packages, bales, and cases, not weighing more than 25 cwt. to the cubic ton measurement, are designated as light freight.

Bale Goods should be stowed on their *flats* in midships, on their *edges* in the wings. In a general cargo, the Dry Goods should be stowed in the after-part of the ship.

In stowing IRON, it should be brought up pyramidally.

LIST OF THE LEADING LIGHTS OF THE ENGLISH CHANNEL.

On the English Coast.

The Light is bright unless otherwise specified.

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Scilly Isles, Bishop Rock ..		F.			Building.
St. Agnes	1	R.	Every minute.	16	
Seven Stones. Light Vessel	2	F.	. .	10	A gong is sounded during foggy weather.
Longships	1	F.	. .	14	
Lizard	2	F.	. .	20	When in one, they lead clear of the Manacles to the E. and of the Wolf to the W.
Eddystonne	1	F.	. .	13	
Start Point	1	R.	Brilliant flash every minute.	19	A fixed light is also shown in the direction of Berry Head, visible only when the Start Point bears to the Southward of W. S. W.
Portland........	2	F.	. .	19 16	When in one, they lead between the Race and Shambles.
Needles	1	F.	. .	27	Red sea-ward; bright towards Hurst Point.

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather	Remarks.
St. Catherine....	1	F.	. .	18	
Bembridge, or Nab, Light Vessel	2	F.	. .	8 10	A gong is sounded during foggy weather.
Owers, Light Vessel	1	F.	. .	10	A gong is sounded during foggy weather. When a vessel is standing into danger, a gun is fired.
Beachy Head....	1	R.	Two minutes; duration of flash 15 seconds.	22	
Dungeness......	1	F.	. .	14	
South Foreland..	2	F.	. .	22 25	These lights in one, clear the South end of the Goodwin Sands.
South Sand Head, Light Vessel	1	F.	. .	10	A gong is sounded during foggy weather.
Gull Stream, Light Vessel	2	F.	. .	7	A gong is sounded during foggy weather.
Goodwin, or North Sand Head, Light Vessel	3	F. triangular.	. .	10	A gong is sounded during foggy weather.
North Foreland..	1	F.	. .	18	

On the French Coast.

Dunkerque......	1	R.	Every minute.	24	
Gravelines......	1	F.	. .	15	
Calais..........	1	F.	Varied by a flash every four minutes.	21	

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Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Cape Grisnez....	1	R.	Every half minute	22	
Ailly...........	1	R.	In 80 seconds.	18	
Fecamp	1	F.	. .	18	
La Heve	2	F.	. .	20	
Point de Ver....	1	F.	. .	15	Varied by a flash every four minutes.
Cape Barfleur ...	1	R.	Every half minute.	22	With the distance of 12 miles the light does not quite disappear.
Cape de la Hague	1	F.	. .	18	
Cape Carteret ...	1	R.	Every half minute.	18	
Casquets	3	R.	Every 15 seconds.	15	All visible at the same time. A bell is tolled during foggy weather.
Chansey........	1	F.	. .	15	Bright varied by red flashes every four minutes.
Granville	1	F.	. .	15	
Cape Frehel.....	1	R.	Every half minute.	22	
Héaux de Bréhat.	1	F	. .	18	
Ile de Bas	1	R.	Every minute.	24	
Ile Viérge	1	F.	. .	15	Bright varied by red flash every four minutes.
Ushant.........	1	F.	. .	18	

LEADING LIGHTS OF ST. GEORGE'S CHANNEL, FOR DUBLIN AND LIVERPOOL.

South, East, and North Coasts of Ireland.

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash	Miles seen in clear Weather.	Remarks.
Cape Clear	1	R.	Every two minutes.	27	
Kinsale, Old Head	1	F.	. .	22	
Cork, Roche Pt. .	1	F.	. .	14	Red to seaward.
Ballycotton	1	R.	Every 10 seconds.	18	
Minehead.......	1	R.	Every minute.	21	Bright 50 seconds; obscured 10 seconds.
Hook Tower.....	1	F.	. .	16	
Saltees......... Light Vessel	2	F.	. .	9	During foggy weather a bell is tolled.
Tuskar	1	R.	Every two minutes.	15	During foggy weather a bell is tolled every half minute. Two sides bright, one red.
Arklow, Light Vessel	1	F.	. .	9	During foggy weather a bell is tolled.
Wicklow Head ..	2	F.	. .	21 16	When in one they lead between the India and Arklow banks.
DUBLIN BAY,					
Kish, Light Vessel,	3	F.	. .	9	During foggy weather a bell is tolled.
Poolbeg......	2	F.	. .	12	
Howth Bailey	1	F.	. .	15	
Carlingford, Haulbowline Rock	2	F.	. .	15	In foggy weather a bell is tolled every half minute.
Dundrum Bay St. John's Point	1	R.	1 minute.	. .	
South Rock.....	1	R.	Every minute and half.	12	

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Copeland	1	F.	. .	16	
Maidens	2	F.	. .	14 13	
Rathlin	1	. .	. .	. .	Building.
Lough Foyle	1	F.	. .	13	
Innistrahull	1	R.	Every two minutes.	18	
Lough Swilly....	1	F.	. .	14	Red; towards the Lough Bright.
Tory Island	1	F.	. .	16	

Welsh and Scotch Coasts, including the Isle of Man,

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Smalls	1	F.	. .	13	
South Bishop....	1	R.	Every 20 seconds.	17	
Bardsey	1	F.	. .	17	
Stack	1	R.	Every two minutes.	19	During foggy weather a smaller light is occasionally shewn, revolving in 1½ minutes.
Skerries	1	F.	. .	15	
Lynus..........	1	R.	Ten seconds. Visible 8 seconds, obscured 2s.	16	
Air............	1	F.	. .	10	A bell is sounded in foggy weather.
Liverpool, North west Light Ship	3	F.	. .	10	A bell is tolled during fogs.

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Bidstone........	1	F.	. .	23	
Entrance to Mersey and Dee Rivers.					
Leasowe......	1	F.	. .	15	In one with Bidstone Light, leads into Horse Channel.
Rock	1	R.	Every minute.	14	Bright twice then red once. A bell is tolled during foggy weather.
Crosby, Light Vessel	1	F.	. .		
Crosby.......	1	F.	. .	13	Red.
Formby ...... Light Vessel	2	F.	. .	8	In one with Crosby Light, leads into New Channel.
ISLE OF MAN, Bahama Bank Light Vessel	2	F.	. .	10	A gong is sounded during foggy weather.
Douglas, on the Head......	1	F.	. .	. .	
Calf of Man ..	2	R.	Every two minutes.	24 22	
Ayre	1	R.	Every two minutes.	15	Bright and Red alternately.
Mull of Galloway.	1	R.	Every 3 minutes. 2½ visible and half minute eclipsed.	23	
Port Patrick.....	1	F.	. .	9	
Corsewall	1	R.	Every 2 minutes.	15	Bright and Red alternately.
Sanda Island	1	F.	. .	15	Red.
Mull of Cantyre..	1	F.	. .	22	
Rhins of Ila.....	1	R.	Every five seconds.	17	

LEADING LIGHTS OF THE BRISTOL CHANNEL.

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather	Remarks.
Lundy	2	Upper R. Lower F.	Every two minutes.	30	
Flatholm	1	F.	. .	17	
Usk	1	F.	. .	10	
Nash	2	F.	. .	18 16	When in one, leading a cables length S. of Nash Sand.
Mumbles.......	1	F.	. .	15	
Helwick, Light Vessel	1	R.	Every minute.	10	A gong is sounded in foggy weather.
Caldy..........	1	F.	. .	19	Part bright, part red. The E. limit of the red light, clears the W. end of the Helwicks, bearing S.E. by S. distance 13 miles.
St. Ann's.......	2	F.	. .	19 17	When in one, they lead clear of the Crow and Toes Rocks

CHARTER-PARTY.

Charter-party is a contract by which a ship or part of a ship is hired for the conveyance of goods, on certain specified conditions. It is not required to be drawn up in any precise form of words, for, as ships may be engaged under a great variety of circumstances, and on voyages of very different characters, and as there are frequently peculiar regulations and customs attaching to certain trades, so there must be a corresponding diversity in the forms of charter parties, which are necessarily adapted to suit the wishes and intentions of the parties concerned, and the trade in which the vessels are to be employed.

A charter-party settles the terms on which the cargo is to be carried and specifies the nature of the voyage: the owners (or agent, or master, as the case may be) usually covenant to provide a ship strong, staunch and in every respect seaworthy, well and sufficiently found in sails, sailyards, anchors, cables, ropes, &c. and other instruments, tackle, apparel, furniture, provision, &c. needful and necessary for such a ship and for the given voyage, together with an able master and a sufficient number of mariners;—binding themselves also that the cargo shall be delivered (the perils and dangers of the seas excepted) well conditioned, and with as much speed as may be, at the place of discharge agreed upon; the merchant or freighter stipulates to comply with the payment promised for freight according to the terms of the contract: and both parties bind themselves in penalties for non-performances of the covenants, articles and agreements in the charter party: it is signed by the contracting parties and a witness.

In a vessel's *home* port, the charter-party is executed by the owner or owners, and the freighter or his agent; but in

a *foreign* port, it is executed by the master, or the owner's authorised agent (if there be such), and the freighter or his agent.

A charter-party executed by the master, at home, under the evidence of the expressed or implied assent of the owner; or when in a foreign port, and there is no evidence of fraud, is binding on the owner.

A charterer may load the vessel with his own goods, or, with those of other parties; or he may underlet the vessel to another, providing no clause in the charter-party prohibits him so doing.

The owners are bound to prepare and furnish every thing necessary to commence and fulfil the voyage. The ship must also be properly dunnaged, according to the usages of the trade in which she is employed, or according to the nature of the cargo: and in stowing the cargo, the various goods must be arranged and placed in the most approved methods, to prevent damage.

Expedition is of the utmost importance in all commercial and maritime transactions, if therefore either party be not ready at the specified time, for the loading of the ship, the other is at liberty to seek another ship or cargo, and bring an action to recover the damages he has sustained by the non-performance of the contract.

If the charter-party specifies any particular route, or names several ports and the order in which they are to be taken, the master must pursue that course; but without such special mention, they must be taken in geographical order, on the usual or shortest course. A deviation from the prescribed or usual course is justifiable for the purpose of repairs rendered necessary by tempests, or accidents, to procure supplies, or to avoid an enemy; but the vessel must be detained no longer than is absolutely requisite, and the voyage

afterwards continued from the port in which she had taken refuge.

For the purpose of loading and unloading the ship, a certain number of days, called *lay days*, are generally agreed upon; it should be specified whether these are working or running days; and in addition it may be stipulated that the freighter is at liberty to detain the vessel a further fixed time, on payment of a daily sum, as *demurrage*. Should the vessels be detained beyond both periods, the freighter is liable to an action for damages, although the delay may not be attributable to any fault on his part.

When no *lay days* are specified, the length of time for loading and unloading must be determined by the nature of the cargo, or the number of days usually allowed at the port.

As soon as the vessel has the full complement of cargo, and all things necessary are arranged, as clearing at the custom house, payment of port charges, &c. the voyage must be forthwith commenced, *weather* permitting.

The master must not take on board any contraband goods, or have in his possession any false or colourable papers, whereby the ship and cargo are rendered liable to seizure; but he must obtain all papers and documents which are necessary to protect the ship and cargo in all the countries to which he is trading.

In time of war, if there is any stipulation to sail with convoy, the master must repair to the place of rendezvous, in good time, and be careful to procure all the instructions issued by the commander of the convoy, as he is accounted answerable for all losses brought about by neglect in such a case.

By the terms of the charter-party, not to be held liable for injuries arising from "the act of God, and the Queen's enemies, &c." the master or owner is not responsible for

damage arising from the sea and winds, unless such injury or damage was the result of negligence or imprudence.

If the master receive goods at the quay or beach, or send his boat for them, his responsibility commences with the *receipt* of them. With goods to be sent coastwise, the responsibility of the wharfinger ceases on delivering them upon the wharf.

When the charter-party names a full and complete cargo, the master must take on board as much as he can, with safety, and without injury to the ship; and the freighter is obliged to furnish the same, either of his own goods, or the goods of others.

If any clause of the charter-party is ambiguous, the interpretation should be liberal, or if the charter-party is silent in respect to any point, the usage of the trade in which the ship is employed must be adopted.

In the case of a vessel having, by the terms of the charter-party, to proceed to a foreign port, the merchants covenanting to furnish a lading there, and being arrived, if the contracting parties or their agents are unwilling or unable to furnish a cargo, on the expiration of the lay days, the master must note a protest against the merchants for non-fulfilment of the charter-party, after which he may seek a freight in another direction.

A prohibition by the government of that country to export the proposed articles, neither dissolves the contract, nor excuses the non-performance of it.

It is customary for the master, before delivering the cargo, and within 24 hours of his arrival in port, to cause a notary-public note a protest "against wind and weather" as the term is, giving the particulars of the voyage—the

storms or gales encountered, protesting that any damage that may have occurred was caused by winds, bad weather, &c.

An instrument of protest can be extended in the proper form when the nature and amount of damage is ascertained. If a survey has been called, which in a foreign port should consist of two masters of vessels, the survey-report must particularize the goods damaged, mentioning their marks, numbers, &c. and being signed, must be given to the master of the vessel.

FREIGHT.

Freight is the sum paid by any merchant or other persons hiring a ship or part of a ship, for the hire of such ship or part, during a specified voyage, or for a certain fixed time.

Freight may be contracted to be paid by the voyage, by the month, or other time, or by the ton, and is usually fixed by the charter-party, or bill of lading; where no formal stipulations have been made, it would be due according to the custom of the trade in which the ship is employed.

As a general rule, no freight is due, unless the voyage has been performed, and the goods delivered at the port of destination, according to the contract; but with respect to living animals, men or cattle, which may die on a voyage, it is ruled that freight is due for dead and living, if no stipulation has been made in respect to them; if however, the contract is for *transporting* them, no freight is due for those dying on the voyage, as the contract is not performed; on the other hand, if the agreement is for the *lading*, then freight is due for dead and living.

If the whole ship is hired, and the freight is to be paid as a gross sum, the whole freight is due, although the freighter does not fully load the ship; or when the freight is to be paid at so much per ton, and the contract is for a full cargo, freight will be according to the *real burden* of the ship, although there may have been an error in the contract in describing the ship of less burden than she really is.

When freight is to be paid at a fixed sum for the whole voyage, the owners take on themselves the chance of the voyage being long or short; but when the freight is to be paid at so much per month or week, of the voyage, the risk of the duration falls on the freighter, who must pay for the whole time occupied, commencing from the day the vessel breaks ground, (whatever obstructions or delays may afterwards occur, provided they are not occasioned by the neglect or fault of the owners or master,) until she arrive at the port of destination.

If freight is stipulated to be paid only on the delivery of the cargo, this must take place before the freight can be demanded.

If by the charter-party a ship is to sail from one port to another, and thence back to the first, the whole being one voyage, no freight is due unless the whole voyage has been performed, although the ship might have delivered her cargo at one port, and she is only lost on returning to the place whence she started; but if the outward and homeward voyages are distinct, and the first only is performed, the ship being lost on the homeward voyage, freight is due for the first.

If the cargo or any portion of it is damaged, through the fault or negligence of the master or crew, the charterer is entitled to compensation, being the amount of depreciation in the value of the goods, less freight; if however, the

damage arises from circumstances over which the master has no control, freight is due, and no compensation for damage is allowed.

The right of a merchant to abandon his goods for freight when they have been damaged, has never been claimed in Great Britain; no freight is due in the event of a total loss.

If a portion of a cargo has been thrown overboard for the preservation of a ship, and she afterwards arrive at the port of destination, the value of the rejected cargo is to be answered to the charterer by way of general average, and the value of the freight thereof allowed to the owner. If the master is compelled to sell a part of the cargo for supplies or repairs, the owner must pay to the merchant the market price the goods would have brought at the place of destination.

If it is found that the ship is disabled and cannot proceed to the port of destination, and the master declines to tranship the cargo, and the merchant does not require him to do this but accepts the goods at the intermediate port, then freight is due according to the proportion of the voyage performed; if the master provides another ship for the transmission of the goods, he will be entitled to the whole freight originally contracted for, although by the second conveyance the goods may be carried for less than that freight; if the freighter will not consent to the goods being forwarded, the master being ready to do so, he will be liable for the full freight of the whole voyage.

If a consignee receive goods in accordance with the usual bill of lading, he is liable for the freight; but a person acting as *agent* for the consigner, it being known to the master that he acts in that capacity, is not liable.

If a ship under a charter-party, is sold *before* the voyage commences, the purchaser is entitled to the charter, but if a

vessel is sold *during* a voyage, the original owner is entitled to it.

When the time and manner of paying freight is mentioned in the charter-party or in any other written contract, the stipulations must be respected.

A master cannot retain the cargo on board, until the freight is paid.

BILLS OF LADING.

A Bill of Lading is a formal receipt signed by the master of a ship, acknowledging that he has received on board the goods specified on it, and binding himself (under certain exceptions,) to deliver them in like good order as received, at the place, and to the individual named in the bill, on the payment of the stipulated freight. The terms of the exceptions above mentioned, are as follows;—" the act of God, the Queen's enemies, fire, and all and every other dangers and accidents of the seas, rivers, and navigation, of whatever nature and kind soever excepted," and in the case of ships homeward bound from the West Indies, which send their boats to fetch the cargo, there is further added, " save risk of boats, so far as ships are liable thereto."

The bills of lading determine the contents of the cargo of a ship.

The master should not sign bills of lading, until the goods are delivered, and on board, and he is satisfied of their condition.

When a ship is hired by a charter-party, the bills of lading are delivered by the master to the person to whom the ship is

chartered, but in a *general* ship, (i. e. a ship in which goods of many different parties are laden,) each person sending goods on board, receives a bill of lading for the same.

It is usual to make out three bills of lading, each of which must be stamped: one for the shipper, another for the consignee or agent, or purchaser, (this is sent by post), and the third is retained by the master for his use and guidance.

Bills of lading are transferable by indorsation, and the master must deliver the goods to the holder of the bill who has acquired a legal right to it.

INVOICE.

An Invoice is a description of goods sold or consigned, with an account of the cost and charges. A shipping or exportation invoice gives an account of the goods, the name of the vessel and of the master, the port of destination, the name of the consignee, the description of goods with the cost and charges and a specification of the account on which the goods are sent.

MANIFEST.

A Manifest is a document signed by the master at the place of lading, and sets forth the name and tonnage of the ship, the name of the master and of the place to which the ship belongs—of the place or places where the goods are shipped—and the place or places for which they are respectively destined; it must give a particular account and

description of all packages on board, with the marks and numbers thereon, the sorts of goods, the different kinds of each sort to the best of the master's knowledge, particulars of goods stowed loose, also a recapitulation of the total number of the packages of each sort, describing them by the names by which they are best known, the names of shippers and consignees, and all other particulars relating to the ship, her cargo, and her passengers.

BOTTOMRY.—RESPONDENTIA.

Bottomry is the mortgaging of a ship, a bond whereby the ship's *bottom* is pledged as a security for the repayment of money borrowed to carry on the voyage: the money advanced together with the premium or interest becomes repayable on the ship terminating the voyage successfully, the vessel as well as the borrower being then liable for the money lent.

If the ship is lost, the lender loses the whole money, and since he has to sustain the hazard of the voyage he is allowed a greater interest or premium than the usual rate acknowledged by law. Money thus obtained must be expended in refitting and repairing the ship.

Money is said to be taken up at respondentia when the loan is not on the vessel but on the cargo, and the lender must be paid principal and interest although the ship is lost, provided the goods are saved.

If, on a voyage, two or more bottomry bonds be entered into, they take precedence in the reverse order, the last being first payable.

Money to be borrowed on bottomry, should always be advertised for, and the lowest offer of interest accepted.

THE OFFICIAL LOG BOOK.

As every master of a vessel must possess the Official Log Book, it is unnecessary to say anything on the manner of using it, an accurate knowledge of which can only be acquired by inspecting the various columns it contains, and ample directions are given in the first pages for this purpose. All the entries must be carefully made and particular attention is required as to the instructions relating to "*Entries of Offences to be read over,*" and "*Entries of Wages and Effects of Deceased Seamen.*"

EXAMINATION

FOR

MASTER EXTRA.

THE VERIFICATION OF THE LATITUDE BY DOUBLE ALTITUDES OF THE SUN.

SUMNER'S METHOD.

1. From the observed find the true altitudes as in the usual method of double altitudes.
2. Get the Greenwich date of *each* observation.
3. From the Nautical Almanac find the Sun's Declination for each date.
4. Select two latitudes, one of which is the degree (without odd minutes) *less*, and the other the next degree *greater* than the latitude by dead reckoning. Or, assume two latitudes from 15′ to 45′ on each side of the approximate latitude, such that there may be a difference of 1° between the two latitudes thus chosen.
5. Find the apparent time from noon in each of the following cases:
   - (*a*). With the first altitude, the corresponding declination, and less latitude.
   - (*b*). With the second altitude, the corresponding declination, and less latitude.
   - (*c*). With the first altitude, the corresponding declination, and greater latitude.
   - (*d*). With the second altitude, the corresponding declination and greater latitude.
6. Obtain the *elapsed time* corresponding to *each assumed latitude* thus:—If one observation be A.M. and the other P.M. take the sum of the apparent times found by *(a)* and *(b)*; if both be A.M. or both P.M take the difference of the results of *(a)* and (*b*); call this

sum or difference the *elapsed time (e) for the less latitude.* Proceed in the same manner, using the results of *(c)* and *(d)*, to find the *elapsed time, (f) for the greater latitude.*

7 Take the difference of the elapsed time *(e)* for the less latitude and the *true* apparent elapsed time, calling the remainder *too little* if the former is less than the latter, but *too much* if the reverse is the case. Find also the difference of the elapsed time *(f)* for the greater latitude and the *true* apparent time, naming the remainder on the same principle as before.

8. When *one* elapsed time is *too much* and the *other too little* take their sum, but if *both* are *too much* or *both too little,* take their *difference* for the error of elapsed time caused by an error of 1° of latitude.

Lastly, make this proportion which can be computed by proportional logarithms:

As the error of elapsed time on 1° of latitude, prop. log. (ar. co.)	+
Is to 1°	+
So is the error of elapsed time for the less or greater assumed latitude	+
To a correction to be applied to that assumed latitude.........( ). prop. log.	

It will be at once seen that when the elapsed time of one assumed latitude is *too little* and that of the other *too much,* the *true* latitude is between the two assumed ones, consequently the correction must be added to the less or substracted from the greater assumed latitude, according to which is used for the determining of the correction. But both the elapsed times of the two assumed latitudes may be too much or *both* too little,—(each case is possible); then the correction

must be applied to satisfy the following conditions; if the elapsed time of the less assumed latitude differs from the true elapsed time by a given quantity, and that of the greater assumed latitude by a less quantity, then the true latitude must be greater than the greater assumed one; also if the elapsed time of the greater assumed latitude differs from the true elapsed time by a given quantity, and that of the less assumed latitude by a less quantity, then the true latitude must be less than the less assumed one.

N. B. This method of finding a ship's position admits of the figure being projected, but hitherto it has not been required by the Board of Examination. Much more might be said on the subject, did space admit; it is however hoped the rule will be found satisfactory, so far as the method by computation is concerned.

Miscellaneous Examples for Practice.

1. June 7th, 1854 : approximate latitude 42° : long. 142°E. : observed meridian altitude $\overline{☾}$ 39° 14′ 40″ : observer N. of ☾ : index error +2′ 15″ : eye 24 feet : required the true latitude.

2. Dec. 29th, 1854 : approximate latitude 47° : long. 152° W. the observed meridian altitude $\underline{☾}$ 60° 40′ 15″ : ☾ S. of observer : index error —1′ 23″ : eye 19 feet : required the true latitude.

3. Sept. 9th, 1854 : A.M. at ship : approximate latitude 31° : long. 160°E. : observed meridian altitude $\underline{☾}$ 58° 11′ 30″ ; observer S. of ☾ : index error —1′ 40″ : eye 18 feet : required the true latitude.

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4. Jan. 18th, 1854, at 7^{h} 15 35^{s} P.M. mean time at ship long. 168° 40′E. : the observed altitude of Polaris off the meridian being 45° 10′ 40″ : eye 21 feet : required the latitude.

5. July 10th, 1854 : at 11^{h} 54^{m} 40^{s} P.M. mean time at ship : long. 171° 50′E. : the observed altitude of Polaris off the meridian being 61° 0′ 30″ : index error, —1′ 39″ : eye 27 feet : required the latitude.

6. Sept. 10th, 1854 : at 2^{h} 30 15^{s} A.M. mean time at ship : long. 30° 17′W. : the observed altitude of Polaris off the meridian being 54° 0′ 30″ : eye 18 feet : required the latitude.

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7. August 5th, 1854 : lat. 37° 3′N. : long. 15° 16′E. : equal altitudes of $\underline{\odot}$ being observed, when the corresponding times by chronometer were 4^{d} 19^{h} 40^{m} 20^{s} and 5^{d} 1^{h} 30^{m} 40^{s} : determine the error of the chronometer for apparent and mean time at the place of observation, and also on mean time at Greenwich.

8. March 2, 1854: lat. 16° 54′N.: long. 25° 22′W.: equal altitudes of ☉ were taken, when the corresponding times by chronometer were $10^h\ 10^m\ 4^s$ A.M. and $3^h\ 56^m\ 14^s$ P.M. determine the error of the chronometer for apparent and mean time at the place of observation, and also on mean time at Greenwich.

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9. April 23, 1854: at $8^h\ 32^m\ 40^s$ A.M. apparent time at ship: lat. 40° 10′N.: long. 34° 18′W.: determine the true and apparent altitudes of the sun and moon.

10. May 5, 1854: at $5^h\ 30^m\ 32^s$ P.M. mean time at ship lat. 48° 55′S.: long. 162° 8′E.: required the true and apparent altitudes of Spica (α Virginis), and of the moon.

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11. May 9, 1854, the following double altitude of the sun was taken:—

app. time at ship,	obs. alt. ☉,
$8^d\ 20^h\ 13^m 40^s$	35° 11′ 21″ bearing S.41°E.
9 0 23 40	59 49 8

the course and distance made in the interval S.70°W. 6 miles per hour: eye, 22 feet: required the true latitude when the second altitude was taken: the ship's position at the time being by account lat. 46° 59′ N.: long. 46° 35′ W.

12. Feb. 19th 1854: the following double altitude of the sun was observed,—

app. time at ship,	obs. alt. ☉
$8^h\ 45^m\ 50^s$ a.m.	41° 30′ 45″ bearing S.76°E.
0 58 50 p.m.	74 20 27

eye 24 feet: the course and distance in the interval being N.24°E. 31·6 miles: required the true latitude when the second

observation was taken, the ship's position being by account lat. 6°4′S.: long. 115° 1′E.

13. Dec. 12th, 1854, the following double altitude of the sun was taken:—

app. time at ship.	obs. alt. ☉
$12^d\ 0^h\ 20^m\ 12^s$	59° 24′ 9″ bearing N. 21°E.
12 4 0 12	35 57 26

the course and distance in the interval, N. 33°W. 28 miles: eye, 19 feet: required the true latitude when the second observation was made, the ship's position at the time being by account, lat. 52° 58′S.: long. 60° 3′E.

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14. Feb. 19th. 1854, A.M. at ship: lat. 6° 4′S.: the following lunar observation was made:—

	obs. alt. ☉	obs. alt. ☾	obs. dist. near limbs.
	41° 36′ 0″	26° 56′ 30″	108° 5′ 40″
index err.	+14	0	—35

eye, 25 feet: time by chronometer, $18^d\ 13^h\ 2^m\ 50^s$, which was supposed to be $17^m\ 6^s$ slow on mean time at Greenwich: determine the error of the chronometer on mean time at Greenwich by lunar: also the longitude.

15. Nov. 15th 1854: A.M. at ship: lat. 39° 50′N. the following observations were made:

	obs. alt. ☉	obs. alt. ☾	obs. dist. n.ls.
	22° 26′ 30″	52° 14′ 40″	59° 46′ 0″
index error	+ 12	— 20	+ 10

eye 16 feet: time by chronometer $15^d\ 1^h\ 0^m\ 58^s$, which was supposed to be $48^m\ 11{\cdot}5^s$ slow on mean time at Greenwich: required the error of the chronometer on Greenwich mean time by lunar, and the longitude.

16. May 9th, 1854, at 8^h 36^m P.M. by watch at ship: lat. 8° 26′ S·: long. by account, 107° 42′W.

obs. alt. Pollux, W. of mer.	obs. alt. ☽	obs.dist. ☾ n. l. & *
19° 30′	69° 15′ 20″	84° 17′ 20″
index error 0	— 1 16	+9

eye, 17 feet: required the true longitude.

17. Feb. 6th, 1854: at 5^h 20^m 46^s P.M. by watch at ship: lat. 50° 13′N.: long. by account, 22°W.:

obs. alt. Venus (centre) W. of mer.	obs. alt ☾	obs. dist: ☾ n.l. and Venus centre
24° 26′ 0″	51° 59′ 0″	80° 9′ 10″
ind. err. +32	+41	— 15

eye, 25 feet: required the true longitude.

18. Feb. 12th. 1854: at 10^h 2^m 2^s P.M. by watch at ship: lat. 4° 16′S: long. by ac. 131° 47′ E.

obs. alt Saturn (centre) W. of mer.	obs alt. ☾	obs. dist. n.l.& ♄
27° 37′ 0″	52° 17′ 10″	82° 4′ 15″
index error + 41	+ 1 3	— 18

eye 21 feet: required the true longitude.

19. Sept. 3rd, 1854: at 7^h 40^m 2^s P.M. by watch at ship: lat. 46° 30′S: long. by account 90° 40′W.

obs. alt. Fomalhaut E. of mer.	obs. alt. ☾	obs. dist.☾ f.l. & *
38° 34′ 50″	57° 43′ 30″	33° 7′ 10″
ind. err. —20	+17	+1 3

eye 23 feet: required the true longitude.

20. A ship by dead reckoning has made S. 7° W. 100 miles, but by observation it is found to have made S. 50° E. 94 miles, reqrired the set and drift of the current.

21. A ship by dead reckoning has made N. 69° E. 82 miles, but by observation it is found to have made S. 65° E. 101 miles, required the set and drift of the current.

22. A ship by dead reckoning has made E. 75 miles, but by observation it is found to have made N. 63° E. 78 miles, required the set and drift of the current.

23. A ship by dead reckoning has made N. 30° W. 105 miles, but by observation it is found to have made N. 20° W. 101 miles, required the set and drift of the current.

Paper I.

1. Jan. 7, 1854 : P.M. at ship: lat. 40° 36′S.:

	obs. alt. ☉̲	obs. dist. ☉ & ☾ n.ls.
	35° 29′ 50″	108° 5′ 40″
index error	—18	+14

eye 27 feet: time by chronometer $7^d\ 6^h\ 20^m\ 2^s$, which was supposed to be $20^m\ 2^s$ fast on mean time at Greenwich: required the longitude, and error of chronometer on Greenwich mean time, by lunar observation.

2. Feb. 17th 1854 : A.M. at ship: approximate latitude, 39°: long. 166° 30′E.: observed meridian altitude ☾̲ 50° 10′ 40″: ☾ S. of observer: index error +1′ 2″: eye 18 feet: required the true latitude.

3. March 20th, 1854: at $7^h\ 17^m$ P.M. mean time at ship: longitude 19° 56′W.: the observed altitude of Polaris off the meridian being 54° 50′ 40″: index error +1′ 10″: eye 23 feet: required the latitude.

4. April 2nd, 1854: the following observations were made for latitude, by double altitudes,

app. time at ship,	obs. alt. ☉̲
$8^h\ 16^m\ 44^s$ A.M.	31° 24′ 13″ bearing E. by S. ¼S.
11 1 44 A.M.	61 0 20

eye 22 feet: course and distance in the interval S.¼E. 28 miles: lat. by account 30° 2′N.: long. 171° 11′E.: required the true latitude, when the second observation was made.

4a. Verify the above by Sumner's method.

5. April 15th, 1854: lat. 16° 50′N.: long. 99° 52′W.: equal altitudes of the sun's lower limb being observed, when the corresponding times by chronometer were $15^d\ 3^h\ 50^m\ 40^s$ and $15^d\ 9^h\ 20^m\ 40^s$: determine the error of the chronometer for apparent and mean time at the place of observation, and also on mean time at Greenwich.

6. April 27th, 1854: the observed altitude of the sun's lower limb, in an artificial horizon, being 61° 15′ 40″: index error, —2′ 10″: required the true altitude of the sun's centre.

7. A ship by dead reckoning has made S.44°E. 97 miles, but by observation she is found to have made S. 11°W. 101 miles: determine the set and drift of the current.

Paper II.

1. May 11th 1854: at $9^h\ 48^m\ 31^s$ P.M. mean time by watch at ship: lat. 38° 40′S.: long. by ac. 171° 6′E.: the observed distance of Regulus (α Leonis) and ☾'s near limb being 65° 50′ 30″: index error +1′ 16″: required the true longitude.

2. May 10th, 1854, approximate latitude 55°: long. 86° 15′E. observed meridian altitude $\underline{☾}$ 40° 10′ 30″: observer S. of ☾: eye, 24 feet: required the true latitude.

3. May 15th, 1854, at $11^h\ 0^m\ 50^s$ P.M. mean time at ship: long. 30° 40′W.: the observed altitude of Polaris off the meridian, being 49° 58′ 40″: index error —50″: eye 22 feet: required the latitude.

4. May 28th, 1854: the following observations were made for latitude by double altitudes,

app. time at ship.	obs. alt. $\underline{\odot}$	
$28^d\ 0^h\ 58^m\ 30^s$	66° 41′ 11″	bearing N.W.
28 3 29 42	35 44 0	

eye 18 feet: the course and distance in the interval S.S.W. 14 miles: lat. by ac. 3° 7′N.: long. 2° 15′W.: required the true latitude when the second observation was taken.

4a. Verify the above by Sumner's method.

5. May 16th, 1854: lat. 20° 28′S.: long. 28° 51′W.: equal altitudes of the sun's lower limb being observed, when the corresponding times by chronometer were $15^d\ 23^h\ 5^m\ 30^s$ and $16^d\ 4^h\ 52^m\ 10^s$, required the error of the chronometer on apparent and mean time at the place of observation, and also on mean time at Greenwich.

6. May 24th, 1854: the observed meridian altitude of the sun's lower limb in an artificial horizon being 97° 43′ 50″: index error +1′ 20″: required the true altitude of the sun's centre.

7. A ship by dead reckoning, makes N. by E. 106 miles, by observation she is found to have made N.N.W. 100 miles; determine the set and drift of the current.

Paper III.

1. Oct. 2nd 1854: at $8^h\,26^m\,54^s$ P.M. mean time at ship: lat. 36° 10′S.: long. by ac. 18°E.: the observed distance of Antares (α Scorpii) from the ☾'s near limb being 74° 46′: index error +5″ required the true longitude.

2. Oct. 7th, 1854, A.M. at ship: approximate lat. 31°: long. 45° 45′W.. observed meridian altitude $\underline{☾}$ 51° 10′ 40″: observer S. of the moon: index error +1′ 9″: eye 26 feet: required the latitude.

3. October 5th, 1854: long. 160° 30′W.: at $7^h\,10^m\,40^s$ A.M. mean time at ship: the observed altitude of Polaris off the meridian being 46° 50′ 20″: eye 18 feet: required the latitude.

4. Oct. 29th, 1854: the following observations were made for latitude by double altitudes,—

app. time at ship.	obs. alt. $\underline{\odot}$
$29^d\,1^h\,13^m\,8^s$	58° 37′ 25″ bearing N.W.¾N.
29 3 38 20	35 16 20

eye 12 feet: course and distance in the interval S.E.¾ S. 13 miles: lat. by ac. 40° 28′S.: long. 1° 5′E.: required the true latitude when the second observation was taken.

4a. Verify the above by Sumner's method.

5. Oct. 4th, 1854: lat. 34° 19′S.: long. 115° 6′E.: equal altitudes of the sun's lower limb being observed, when the corresponding times by chronometer were $3^d\,19^h\,0^m\,50^s$ and $3^d\,23^h\,50^m\,50^s$: required the error of the chronometer for apparent and mean time at the place of observation, and also on mean time at Greenwich.

6. Oct. 10th, 1854: the observed altitude of the sun's lower limb in the artificial horizon being 65° 10′ 40″: index error +2′ 4″: required the true altitude of the sun's centre.

7. A ship by dead reckoning makes E. 158 miles, but by observation, N.48°E. 130 miles: required the set and drift of the current.

Paper IV.

1. Nov. 29th, 1854: at $6^h\ 42^m\ 24^s$ P.M. mean time at ship: lat. 24° 58′N.: long. by ac. 134°W.: the observed distance of Jupiter's centre from ☾'s near limb being 79° 44′ 20″: index error —16″: required the true longitude.

2. Nov. 27th, 1854: approximate lat. 34°: long. 48° 15′W.: observed meridian altitude ☾̲ 45° 10′ 40″: observer N. of moon: eye 17 feet: required the true latitude.

3. Nov. 15th 1854: long. 30° 15′W.: at $9^h\ 10^m$ mean time at ship: the observed altitude of Polaris off the meridian being 56° 20′ 30″: index error —1′ 2″: eye 19 feet: required the latitude.

4. Sept. 4th, 1854: the following observations were made for latitude by double altitudes,

app. time at ship.	obs. alt. ⊙̲	
d h m s	° ′ ″	
3 19 53 55	22 56 50	bearing N. 72°E.
3 23 8 25	59 5 5	

eye 21 feet: course and distance in the interval N. 72°E. 19 miles: lat. by account 20° 51′S: long. 84° 5′W.: required the true latitude when the second observation was made.

4a. Verify the above by Sumner's method.

5. Dec. 9th 1854: lat. 48° 52′N.: long. 144° 46′E.: equal altitudes of the sun's lower limb being observed when the corresponding times by chronometer were $8^d\ 20^h\ 12^m\ 42^s$ and $8^d\ 22^h\ 30^m\ 46^s$: required the error of the chronometer for apparent and mean time at the place of observation, and also on mean time at Greenwich.

6. Nov. 17th, 1854: the observed meridian altitude of the sun's lower limb in an artificial horizon being 79° 46′ 30″: index error —1′ 16″: required the true altitude of the sun's centre.

7. A ship by dead reckoning had made N.W. 76 miles, but by observation it is found she has made S. 81° W. 61 miles: required the set and drift of the current.

GREAT CIRCLE SAILING.

1. If, on a Mercator's Chart, any two places (not on the equator, nor on the same meridian) be selected, we see that the shortest distance between them is a straight line, and providing no land intervene and the winds and currents are favourable for the purpose, the navigator has no occasion to change the course on which he starts, in order to sail from the one to the other.

2. On a terrestrial globe, apply a piece of thread (stretching it evenly) to the same two places, and it will then be seen, that the shortest distance between them is *not* on a straight line, but on a portion of a circle, and in order to to arrive at either place from the other, by such a route, the course to be sailed must be *constantly varying.*

(a.) When both places are on the equator, or on the same meridian, the track on the great circle and that on the rhumb line are the same, and the course will be N.,S.,E., or W., according to the relative position of the ports.

3. Now the Earth is an oblate spheroid, or sphere of revolution, and the small difference between the equatorial and polar diameters does not preclude our regarding it as a perfect sphere in numerous computations.

4 If a sphere be cut in any direction by a plane, the section must be a circle.

(a.) If the plane pass through the centre of the sphere, we have a *Great Circle,* and the sphere is divided into two equal parts: the equator and meridians are examples.

(b.) If the plane does not pass through the centre of the sphere, the section is a *Small Circle,* dividing the sphere unequally: take the parallels of latitude as examples.

5. Two great circles always intersect in two points at the distance of a semicircle from each other.

(a.) The equator, which is a great circle, bisects every other great circle on the earth's surface, and there must necessarily be two points in every such circle, equi-distant from the equator, and at the same time furthest removed from it: each of these points is called "Vertex;" and the "Latitude of Vertex," which is the highest latitude attained in sailing on a Great Circle, is the nearest approach to the elevated pole. The meridian cutting the great circle at right angles, and dividing it into quadrants, is called the "Meridian of Vertex;" and the "Longitude from Vertex" is the arc of the equator intercepted between the meridian of any place and the meridian of Vertex.

6. The arc of a great circle joining two points, is the shortest distance between them on the surface of a sphere.

(a.) The same great circle cannot be drawn through more than two points, selected at random on the surface of a sphere.

7. A spherical triangle is the portion of space on the surface of a sphere, included between three arcs of intersecting great circles. All the computations for Great Circle Sailing are performed by Spherical Trigonometry.

8. The configuration of the earth is truly represented on Mercator's chart only at the equator, every where else it is distorted: the great circle track between any two places, drawn on such a chart, instead of appearing (as it really is,) the shortest, would be represented as a curved line. It is impossible, under any circumstances, to sail a ship on the true great circle track, but a very close approximation may be made to it in some latitudes; and moreover a knowledge of Great Circle Sailing is very useful in all latitudes, for when adverse

winds are encountered, it teaches on which tack to lay the ship, in order to arrive most speedily at her destination.

These few observations will suffice, since it is not required to enter into calculations, and it is necessary to be provided with Towson's "Tables to facilitate the Practice of Great Circle sailing," at the end of which will be found explanations as to their use, as well as of the linear index which accompanies them.

GREAT CIRCLE TRACKS AND DISTANCES, AND AZIMUTHS WITHOUT CALCULATION.

Mr. RUSSEL has supplied Diagrams of Great Circle Sailing (published by Mrs. TAYLOR, of the Nautical Academy, in the Minories), by which the science becomes little more than a mechanical operation, and which relieves it of all the difficulty of abstruse calculation. On Mr. Russel's sheet there is with a Spherical Diagram, a Mercator's Chart,—to facilitate the finding of the Great Circle, and the distance between any two given places.

The principle on which the Diagram is constructed may be easily understood; for, as every Great Circle cuts the Equator in two points diametrically opposite, it follows that a series of Great Circles drawn through a given point in the Equator, in every possible direction, will all meet at another point in it, 180° distant from the former. Any person accustomed to navigate his ship by Great Circle Sailing will readily understand the nature and advantage of Mr. Russel's plan; and we recommend it to the attention of commanders of vessels, who are bound on distant voyages.

Vide Shipping Gazette, March 19, 1853.

LAW OF STORMS.

BY. W. R. BIRT.

Author of the "Article on Atmospheric Waves." in the Admiralty Manual of Scientific Enquiry; "The Hurricane," and "Sailor's Guides," Etc., Etc.

The object of the following remarks on Revolving Storms, is to exhibit the importance of gaining such a knowledge of the "Law of Storms," that the commander of a vessel may know instinctively what part of a Cyclone he may be in; for this, nothing more is requisite, than that he possess a competent knowledge of the bearing of the centre from the ship, as determined by the direction of the wind; and the result of the hauling of the wind with or against the sun, as indicating on which side of the axis line he may be placed, the axis line coinciding with the *path of the centre*; with this knowledge all instruments may be dispensed with, except the barometer.

1. Within the last 30 years the assiduity of meteorologists has developed a most important and highly interesting department of meteorology. This department has immediate reference to, and must exert a most beneficial influence on the Commercial and Maritime interests of the Country. It is now popularly known as the Law of Storms, and on no class of men can the study of it tell with more effect than on the mercantile marine; not that Her Majesty's Navy stands less in need of the important knowledge contributed by an investigation of storms, but the education of its officers fits them more readily to appreciate and apply such knowledge when overtaken by a hurricane or cyclone.

2. The primary idea or fundamental notion of a cyclone is, that of a vast body of air in a state of rotation, more or less rapid. This rotation appears to be immediately connected with the rotation of the earth, or rather with the apparent course of the

sun in the heavens, arising from the earth's rotation on its axis. The rotation of the air around the azis of the cyclone producing the hurricane wind, is *always* contrary to, or against the apparent course of the sun, and as the apparent course of the sun is reversed in the opposite hemispheres, so the rotation of the air in the cyclone is in opposite directions on either side of the equator. A very simple rule is deducible from these beautiful facts. In the northern hemisphere the cyclone rotates in a direction contrary to that in which the hands of a clock move, but in the southern hemisphere the rotation coincides with the movement of the hands.

3. This whirling of the air in a cyclone, enables us to characterize certain portions of the storm by certain hurricane winds; thus, in the northern hemisphere the *northern* margin of the storm always exhibits an *easterly* wind, the *eastern* margin a *southerly* wind, the *southern* margin a *westerly* wind and the *western* margin a *northerly* wind; we shall also further find upon dividing the storm into quadrants by diameters drawn from the northern to the southern, and from the eastern to the western margins, that upon the *northern* semi-diameter, or radius, the wind will be *east*; on the *eastern*, *south;* on the *southern, west;* and on the *western, north;* each portion of the cyclone will possess its appropriate wind.

4. The relation of the winds to the margins and semi-diameters in the southern hemisphere, will be exactly the reverse of their relations in the northern; thus it is the *southern* semi-diameter and margin of a storm, south of the equator, that exhibits an *easterly* wind, the *western* a *southerly,* the *northern* a *westerly,* and the *eastern* a *northerly.*

5. This arrangement of the winds in a hurricane will conduct us to a very simple rule for determining the position of a vessel in a cyclone, and as a consequence the bearing of the centre of the storm from the ship. From an *easterly* wind

in the northern hemisphere, the centre will bear *south*, or *eight* points, *reckoned in the same direction as the apparent course of the sun*, an *easterly* wind characterising the *northern* margin; from a *northerly* wind the centre will bear *east*; from a *westerly* wind it will bear *north*; and from a *southerly* wind, *west*; thus the direction of the wind *only* in a revolving storm, will announce to the commander of the vessel, two very important points,—his exact position in the cyclone, and the bearing of its centre from his ship.

6. The same simple and very perspicuous rule holds good in the southern hemisphere. From an *easterly* wind, the centre of the storm bears *north* or *eight* points, *reckoned in the same direction as the apparent course of the sun*, the sun rising in the east, culminating in the north, and setting in the west. From a *southerly* wind the centre bears *east*; from a *westerly*, *south*; and from a *northerly*, *west*. These bearings are precisely the *reverse* of those in the northern hemisphere, but as the apparent motion of the sun is also *reversed*, the rule is applicable to both hemispheres. THAT THE CENTRE OF A REVOLVING STORM BEARS *EIGHT* POINTS FROM THE DIRECTION OF THE WIND AT THE SHIP, RECKONED WITH THE APPARENT COURSE OF THE SUN.

7. While the atmosphere *within* the cyclone is in so rapid a state of rotation, that the moving air frequently attains a velocity of about one hundred miles an hour, the exterior zone is strikingly characterized by certain meteorological appearances, which herald, as it were, the approach of the coming storm. The rapid motion of the air within the whirl, combined with the *sucking in* of the exterior air comparatively at rest, produces an immense condensation of vapour generally seen on the horizon in the direction of the cyclone, as a dense, dark, lofty wall or bank of cloud. As the vessel approaches the storm, this bank of cloud appears to advance,

and draw down closely upon the ship, so that she becomes involved, and then the clouds present so appalling an aspect, they appear to be so close to the vessel, and so solid in their structure, that a commander may almost fancy he can from the vessel, put his hand on them.

8. When the ship approaches so near the cyclone, as to experience the effect of the outward gyration, the weather becomes still more significant, the proper wind of the hurricane generally characterized as strong and squally, carries over the vessel portions of the great bank of cloud peculiar to the storm, these portions are torn into rags and shreds, while the bank still marks the locality of the cyclone. From this point a run of two hours *toward* the centre will generally involve a ship in an impetuous and terrific hurricane.

9. The feature next in importance to the rotation of a cyclone, is its progressive motion, and this in all ordinary cases is reducible to the same order and regularity as we have seen characterizing the rotation; commencing at a point a few degrees north of the line, the cyclone moves bodily forward towards the west, its course is however soon directed a little north of west, and as it approaches towards 20°N. lat. its course is more or less towards N.W., at 30°N. lat. its course for a short time is due north, here it *recurves,* and afterwards is directed towards the N.E. This course is peculiar to the western portion of the basin of the Northern Atlantic. The usual storm paths in this locality, may be divided into ordinary and extraordinary. The ordinary conforming to the course above mentioned, and the extraordinary, departing from this type.

10. Upon combining the rotatory with the progressive motion, some very valuable rules for the guidance of commanders may be deduced. The path which the axis of gyration describes, is not inappropriately termed the *axis line,* and

this divides the cyclone into two *semi-circles*, the right or *starboard* semi-circle, and the left or *port* semi-circle; we have consequently three divisions of a storm, each characterized by different phenomena. In the right hand semi-circle, the hauling of the wind resulting from the passage of a cyclone, in the northern hemisphere, is in the same direction as the apparent course of the sun, but in the left hand semi-circle it is reversed, being opposite to or against the sun. On the axis line there is no change of wind until the centre has passed, when after a short lull or calm, the wind springs up with great fury from the opposite quarter.

11. The rules deduced from the progressive motion of a storm, combined with its rotation, are probably best enunciated as well as elucidated by a series of examples, of which the first has reference to the western portion of the basin of the Atlantic, where the ordinary storm paths follow more or less the course of the Gulf stream.

(a.) A vessel pursuing the usual course to the West Indies, shortly after passing 50° W. long. observes unmistakeable meteorological signs of a hurricane bearing down upon her, *i.e.* the dense bank of cloud, &c. is seen astern, not ahead; when she becomes involved in the scud, and the jagged and torn clouds skirting the cyclone are flying swiftly past her, the steady N.E. trade is replaced, not by a wind from a different quarter, but by a wind still from the N.E. of greater intensity, and characterized by strong and sudden squalls; she is now upon the N.W. margin, or rather just within the N.W. verge, the centre bears S.E. of her, and if she scud before the wind, she will approach the axis line of the storm. If however, she should heave-to on the *starboard* tack, and allow the cyclone to pass over her, the wind will haul by E.N.E.-E.-E.S.E.-S.E. and S.S.E.

this will be in accordance with the apparent course of the sun, and an extensive generalization indicates that in the northern hemisphere the wind always HAULS WITH THE SUN IN THE RIGHT HAND, OR STARBOARD SEMICIRCLE OF A ROTARY STORM.

(b.) A vessel pursuing the same course, when overtaken by a cyclone, and observing the significant meteorological signs, experiences a slight change of the N.E. trade; the wind changes to N.N.E. and rapidly increases in force, until at last, with a very furious wind from the same quarter, N.N.E., it becomes suddenly calm; after this calm has continued about half an hour or more, the wind as suddenly springs up from the opposite quarter, or S S.W.; while this wind continues, its force abates until the storm has passed, and the N.E. trade again resumes its sway. In this instance, at the commencement of the storm, the centre of the cyclone bears E.S.E. of the ship, and afterwards passes over it, so that the general rule may be deduced, that ON THE AXIS LINE, A VESSEL EXPERIENCES ONLY TWO WINDS, ONE THE OPPOSITE OF THE OTHER, WITH AN INTERVENING CALM BETWEEN.

(c.) A third vessel experiences a still greater change of wind; the N.E. trade instead of being replaced as in the first instance, by a violent wind from the same quarter, (the N.E.) is succeeded by a northerly wind. If this vessel lie-to on the starboard tack, the winds she will experience will be as follows, N.W.–W. and S.W. The hauling in this case is exactly in the opposite direction to that in the first instance, it is contrary to, or against the apparent course of the sun; THE HAULING OF THE WIND THEREFORE, IN THE LEFT HAND OR PORT SEMICIRCLE OF A REVOLVING STORM IN THE NORTHERN HEMISPHERE, WILL ALWAYS BE AGAINST THE SUN.

These rules will be found very valuable. The direction of the wind at the ship, will give her position in the storm as referred to the points of the compass, and what is of immense importance, the bearing of the centre from her; the hauling of the wind will announce her position relative to the axis line and combined with her track through the cyclone, will give the direction in which the storm itself is moving; if the wind be found to increase in force *without hauling,* the ship is on the axis line, and if a calm occur, succeeded by a terrific and violent wind from the *opposite quarter,* the ship has passed through the centre.

12. Most of the West Indian vessels, and those navigating portions of the Atlantic Ocean, off the Mexican Archipelago, will generally experience the winds of the starboard semi-circles of cyclones, in which they may happen to be involved. It will only be, as a general principle, when they are within the Caribbean Sea, the Gulf of Mexico, or the Channels between the Islands, that they will experience the winds of the port semi-circle. In the latter instances, there are no means of avoiding the fury of the storm by standing towards the margin, except it should sweep over the more open parts of the Caribbean Sea, and Gulf of Mexico. Vessels in the Atlantic may readily avoid the violence of the winds of the starboard semi-circle, by standing to the north and north-east and by being so trimmed that they may receive the cyclone wind on the starboard side of the ship.

13. We are here introduced to a rule of very considerable importance, in manœuvring a vessel when overtaken by a storm of a revolving character. In the northern hemisphere, if a ship receive the wind on her *port* side, her head is directed more or less *towards* the centre of the cyclone; but if she receive it on her *starboard* side, her head is turned *away* from the centre. These facts readily indicate the means to be

adopted, either to retire to, or beyond the margin of the storm, or to draw from the centre when lying to. If with the ship's head from the centre, she receive the wind on the starboard side, then lying to or drawing from the centre, she must be trimmed on the *starboard tack.**

14. In the example (a) a West Indian vessel taking the storm at N.E. it is stated " that if she scud before the wind she will approach the axis line of the cyclone," she will in fact be rapidly approaching *the centre,* which in consequence of its curved path, is likely under these circumstances, soon to overtake her. In no other part of the storm does a vessel so rapidly near the centre by scudding as in this, and the *octant of the starboard semi-circle in advance of the centre and abutting on the axis line* is consequently regarded as by far the *most dangerous* portion. When the gale sweeps along the islands separating the Caribbean Sea and Gulf of Mexico from the Atlantic, the most dangerous octant is characterized by north-easterly and easterly winds.

15. Mr. Piddington in one of his admirable works on Indian Storms, has this pertinent remark on the utility of the barometer, " He who watches his barometer, watches his ship." The barometer is an invaluable instrument in a cyclone, it announces to the commander his approach to the vicinity of a revolving storm, it advertises him of his plunging into its vortex, it acquaints him with his recess from the centre, and by carefully noticing its indications he may, to a great extent, avoid the disastrous consequences of a hurricane, for the laws of its oscillations in a cyclone, are very distinctly marked.

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* The reverse of this takes place in the Southern Hemisphere, a vessel sailing *out of* the gale, receives the wind on her *port* side, she must therefore be trimmed on the *port tack.*

16. A short time before the significant meteorological appearances noticed in sections 7 and 8 are observed, the atmosphere is generally, especially in certain latitudes, very calm, the air is oppressively sultry, and the barometer usually stands very high. Observations appear to indicate that this is mostly, if not always the case, *around* the storm, so that it is surrounded by a margin, characterized by a ***high barometer*** and a hot, sultry atmosphere. In the direction of the cyclone, the clouds assume the appearance of a dark, livid bank, in most cases presenting an appalling and threatening aspect. If a diameter of the cyclone be drawn transverse to the axis line, dividing the starboard and port semi-circles into two equal quadrants, it will exhibit those portions of the storm, in which the barometer will fall and rise. While the first half of a storm passes a ship, the barometer will fall, and while the succeeding half passes it, the barometer will rise. The transverse diameter will also be characterized by a barometer which is proportionably lower, as the centre of the cyclone is approached. In most cases of manœuvring, it is desirable to keep just within the verge of the storm; and here, the barometer is of signal benefit, as, by keeping it as high as possible without losing the cyclone winds, the vessel is kept just within the margin. In whatever position the ship may be, the rising of the mercury announces that the first half has passed.

17. Vessels navigating the Atlantic, off the Bahamas, and Florida, will experience important differences in the phænomena, according as they pass through the starboard, or port semi-circles of a cyclone. Sweeping along the West Indian Archipelago, the path of the cyclone has been, more or less, towards the north-west: a vessel with a north-westerly course receives the northern margin of the gale with the wind from east, and if she pursue her course, the cyclone gaining on her, she soon experiences a favourable wind for her voyage, the

barometer falls until she is fairly under the influence of the S.E. wind, and by sailing parallel with the centre, she has a fair wind for the rest of her voyage, *provided the cyclone does not alter its direction: the fresh breeze from the S.E. with a steady barometer, indicates that she preserves her parallelism with the centre.* If, however, the barometer fall, and bad weather be rapidly experienced, the course of the ship no longer continues parallel with that of the gale; the centre is rapidly nearing her, and if means were not adopted to keep the vessel near the margin, it would, under the circumstances here supposed, be so involved, that the centre would shortly overtake her. In the locality mentioned, a S.E. wind will invariably conduct the vessel to the centre, but if she lie-to as soon as she finds the barometer falling, she will avoid getting nearer the centre, the wind will continue to haul with the sun, and the gale will finally leave her between S.W. and W. The most advantageous manœuvre in these localities, would be to lie-to, as soon as unmistakeable indications of the cyclone *recurving* were perceived; "to wait on it," (to use the expressive phrase of an East Indian Captain,) until the passage of the S.E. wind succeeded by a rising barometer, gave notice that the first half of the gale had passed, and then to cross the receding portion as far from the centre as may be consistent with safety, in order to pursue the original course of the vessel.

18. From the above remarks it is evident, that if a vessel navigating these seas, take the cyclone with any wind in the port semi-circle, the recurving will so operate that the vessel will soon be removed from its influence, but a vessel in the starboard semi-circle requires more than ordinary care in manœuvring, to avoid the centre bearing down upon her.

19. Vessels bound from England to America, as they approach the coasts of the United States, will usually experience the starboard winds of a cyclone: these winds will differ,

to some extent, from those characterizing the starboard semicircle of the West Indian hurricanes, inasmuch, as the general direction of the storm path is, in the case before us, towards the N.E. Upon the track, south of the Gulf Stream, the vessel may take the hurricane by sailing into it at two points; she may either sail into the posterior quadrant, getting a westerly wind, which upon her waiting, will soon leave her; or the hurricane may meet her in the most dangerous octant, with the wind at south: in this case, upon her lying to, the wind hauling with the sun, she will experience the following winds, S.,-S.S.W.,-S.W.,-W.S.W. and W.: as in this case, and also in those of the two northern passages, a vessel upon being involved, will have the hurricane interposed between it and the land, the most prudent step appears to be, "to wait on the cyclone," until the S.W. wind has passed, and the barometer begins to rise, when the earliest opportunity may be embraced for crossing its wake.

20. The entire storm paths of the Western Atlantic, are characterized by certain winds, that are *most dangerous* to vessels falling in with the West Indian and North American cyclones. Off the West Indian Islands, the most dangerous cyclone winds are, N.E. and E.N.E, A short time before recurving, or rather about the period of recurving, vessels off the Bahamas and Florida, find E., E.S E. and S.E. winds most dangerous: after recurving, vessels off the coast of the United States, are placed in considerable jeopardy by S.S.E. and S. winds. The general sweep of dangerous winds in the Northern Atlantic, may be thus specified:—

N.E.,-E.N.E.,-E.,-E.S.E.,-S.E.,-S.S.E. and S.

21. The hurricane season generally sets in, in the Northern Atlantic, as the sun is leaving the tropic of Cancer, shortly after the summer solstice, and continues until he has passed

to some distance south of the equator; the cyclone months are consequently, July, August, September and October.

21*. The remaining localities in which storms are frequent, in the northern hemisphere, are the Bay of Bengal, and the China Seas. In the Bay of Bengal, the progressive motion is towards the N.W. or, more properly speaking, from E.S.E. to W.N.W. The same rules apply to these hurricanes, as to those of the Northern Atlantic, the hauling of the wind on each side of the axis line, being similar to the hauling, in a West Indian hurricane, *before recurving;* consequently, the winds affecting the ship, are the same. In the China Seas, the progressive motion, hauling of the wind, &c., are almost identical with those in the Bay of Bengal, and in both localities, no recurving is observed. The hurricanes in the bay, and the typhoons in the China Seas, appear to lose themselves in, or are dispersed by, the more elevated continental tracts, over which they pass, before they can reach the locality of recurving, in the northern hemisphere.

22. We have already alluded to the fact, that the rotation of a cyclone in the southern hemisphere, is exactly opposite to the rotation of one in the northern, (sec. 2.), both being opposed to the apparent course of the sun. The hurricane region, south of the equator, extends, more or less, over the entire area of the S.E. trades, in the Indian Ocean, the season in which they occur, being characterized, as in the northern hemisphere, by the sun leaving the tropic, and approaching the equator; this is from December to April, as the sun leaves the tropic of Capricorn. Hurricanes are very seldom met with in November or May, and in the remaining five months of the year, so far as our present knowledgde extends, they are unknown.

23. The progressive course of the southern cyclones is in accordance with similar laws characterizing that of the northern;

commencing a few degrees south of the equator, they move first towards the west, very slightly inclined to south; as they approach 20° S. lat., the direction of their progress becomes S.W., and just before reaching 30°S. lat., they recurve, after which they move towards the S.E., and there is great reason to believe, that not very long after the point of recurving, their progressive motion is nearly due east.

24. There appears to be a very remarkable, and most interesting difference, in the latitudes of recurving in the southern hemisphere, as compared with the northern; while the latitude of 30°, may be regarded as the *mean* locality of recurving, so far as distance from the equator is concerned, the cyclones of the Indian Ocean are liable to recurve on any meridian, between the Cape and the western coast of Australia, and it would appear from observations, that they recurve in *lower* latitudes on the more *eastern* meridians. In this way taking the apices of the cyclone paths more and more west, a curved line may be traced from about 60°E. long. to the Cape, on which the latitude of recurving varies from about 28° to 35° south. This line of recurving is of very considerable importance, when it is considered that the great highway of the ocean, from India and China to the Cape, is nearly identical with it, indeed, the two may be considered as pursuing the same track for about 20 degrees of longitude, viz. from 70° to 50° east, so that vessels coming from India and China, and sailing through this portion of the Indian Ocean, any time between December and April, are not only liable, on any day either to sail into a cyclone, or have one bearing down upon them, but their manœuvring may be proportionably complicated by the hurricane recurving, while they are within its influence.

25. The progressive motion of a southern cyclone combined with its rotation, will produce phenomena, as well marked

as those which we have seen characterizing the northern storms. A vessel steering W.S.W., in the S.E. trades, observes all the significant meteorological signs of a hurricane astern, and particularly to windward. The wind alters its character; instead of being a steady, fresh breeze, it becomes gusty and squally, the atmosphere is obscured, patches of cloud come away from the denser masses, of a loose, vapoury, ragged and torn character. These appearances, in such a locality are decisive, the ship is on the S.W. verge of a cyclone, and most probably on the axis line. In this instance, the winds of the S.E. verge, are peculiarly favourable for the prosecution of the voyage, being north easterly. Two points are consequently matters for consideration, viz., to avoid the centre, and to get a favourable wind from the storm,—the liability of the cyclone to recurve, must not however be lost sight of, and the commander must keep a sharp and steady look out for the first indications of a change in the direction of its progress. To avoid the centre and get on the southern verge the commander may stand to the southward, during which the cyclone may gain westing, and pass the meridian of the ship, at which juncture the wind will be easterly; the course to the south, provided the ship remains within the disc, may be continued until the wind becomes N.E., when the body of the storm is to the N.W. of her.

26. While these manœuvres are in progress, great care must be exercised, and a sharp look out kept for the *bend.* If upon standing to the S., when the earliest appearances of the neighbourhood of the cyclone are recognized, the weather does not improve, the hurricanes is recurving, and a very slight westing will bring the vessel again into the steady trades, and fair weather; the ship in such a case, just grazes the verge of the storm. When the ship takes the cyclone at E.S.E., and the commander,—apprehending the motion of the storm to be

W.S.W., waits until it gets westing, so that the verge may leave the ship with an E.N.E. wind,—finds that the easterly wind not only *hangs*, but bad weather is rapidly increasing; another indication is afforded of the cyclone recurving. In this case, loss of time may involve loss of ship. The westing of the vessel is now of the utmost importance, to remain hove-to when the significant signs of the centre bearing down from the north are unmistakeable, must expose the ship to all the fury of the gale, the best manœuvre appears to be, so to trim the vessel, that she may sail from the axis line toward the west, both ship and storm are then trending in opposite directions, which will the more quickly tend to extricate her.

27. Returning to the consideration of the case, (sec. 25,) in which the commander waited until he found himself on the S.E. verge, and a little further westing of the storm would leave the ship no longer exposed to its influence; it must be borne in mind, that although he might thus with ease, escape its fury, it would at some part of its course *recurve*, and very probably, he would again encounter it; if, however, before his leaving the cyclone, the wind should continue to veer, the weather, instead of improving, should grow worse; and a northerly wind blow with increasing violence, then the commander could draw no other conclusion, but, that the hurricane had then arrived at the apex,—the western-most point of its path,—and was recurving, his object now would be, by waiting to allow it to retain sufficient southing, so that he might cross its wake, without deviating from his usual course.

28. There are two or three points that require especial notice in hese examples, the veering of the wind was S.E.–E. N.E., *i.e.*, with the apparent course of the sun; the semi-circle in which the ship manœuvred, was the port, or left-hand semi-circle, and the octant in which the ship took the gale, was the most dangerous. These facts furnish a general law,

applicable to all storms in the Indian Ocean, viz. IN THE RIGHT HAND, OR STARBOARD SEMI-CIRCLE, THE WIND HAULS AGAINST THE SUN; AND IN THE PORT, OR LEFT HAND SEMI-CIRCLE WITH IT; the most dangerous octant is in the port semi-circle, in advance of the centre, abutting on the axis line, and in the great majority of cases, characterized by a S.E. wind, so that *before recurving*, a S.E. hurricane wind is the most dangerous.

29. A vessel, north of the axis line, has not near so much to contend with, as one south of it: if she take the gale on the N.W. margin, with the wind at S.W., by standing northward she may rapidly extricate herself, especially if the gale be about recurving; almost under any circumstances, by such a manœuvre, the centre of the storm and vessel are rapidly parting company.

30. The rotation of the wind in a storm violently agitates the surface of the ocean, producing a swell or *storm wave*, this wave is propagated in the same direction as the wind, characterizing the margin to which the swell is a tangent. The *undulations* thus rolling from the margin, both in advance and regression of the storm itself, encounter each other and produce in the area of intersection, *cross seas* which are more or less dangerous, according as they are met with in advance or behind the hurricane. As the cyclone advances, a series of undulations are thrown off to the right and left, which flow in the direction of the two radii of the storm, dividing its semi- circles into quadrants. It is easy to see that these undulations *fringe* the storm's wake, they are found in fact to the right and left of the path which the storm has described.

31. In the left-hand or port semi-circle, in the northern hemisphere, and in the right-hand or starboard semi-circle, in the southern, a sea is given off which meets the undulations flowing to the right and left of the storm's path, and produces in the *left-hand side* of the storm's wake, in the *northern*

hemisphere, and in the *right-hand side*, in the southern hemisphere, a tremendous pyramidal sea. When this cross turbulent sea is encountered, it is a pretty sure indication that the storm itself has passed the locality. A few examples in the southern hemisphere, will illustrate the effect of the cross seas, according as they are met with, in advance, or on the right or left hand of the storm's path.

32. A vessel in the Indian Ocean meets with a cyclone wind at S. heralded by the significant meteorological signs, characterizing the approach of a hurricane, but has not experienced any remarkable disturbance of the nature of a cross sea. This is a very dangerous position, inasmuch that if the commander depend on the appearance of the sea, as an indication of the proximity of a hurricane; he may here be greatly mistaken. The wind, its hauling and meteorological accompaniments, are sure indications of the presence of a cyclone; and it may be added, that *the absence of a cross sea* is also an indication of the vessel being on the confines of the most dangerous octant.

Another vessel with the wind at N.W., experiences a mighty hubbub, she is involved in a turbulent pyramidal cross sea, and this is the greatest difficulty she has to encounter, the cyclone is leaving her in its wake, which is characterized on the starboard side, by a "heavy cross sea."

A third vessel experiences the easterly winds of a cyclone, free from a turbulent cross sea. As the wind veers to E.N.E. the cross sea overtakes her, and if she continue in the wake of the hurricane, she will continue to experience the cross sea, but not to the extent that a vessel in the starboard or opposite side of the wake will.

QUESTIONS

To be answered by Commanders of Steam Vessels under examination in the practical use of the Steam Engine.

Explain the nature and use of the principal valves and cocks connected with the boilers and engines, commencing with the boilers.

Boiler Valves and Cocks.

Safety valves.
Reverse or atmospheric valves.
Communication or stop valves.
Feed valves.
Kingston valves.
Blow-off cocks.
Communication cocks.
The water-guage cocks.
The glass water guage
Steam guage.
Hand-pump for boilers.

Engine Valves and Cocks

Throttle valves
The slide valves.
The expansion valves.
The escape valves on top and bottom of cylinder
The blow-through valve.
The foot valve.
The delivering valve.
The air-pump bucket valve.
The injection valves and cocks.
Bilge-pump valves and cocks.
Stop or sluice valves to discharge pipes.
Jacket cocks.
The snifling valves.

Boilers.

1. If the safety valves were set fast, how would you relieve the pressure on the boilers, if steam was up and could not make its escape?

2. How do you ascertain the saltness of the water in the boilers?

3. How would you manage to change the water in the boilers, if the blow-off cocks were set fast?

4. On examining the boilers, and they are found to be thin, what measures would you adopt to prevent accidents?

5. How would you keep the boiler free from salt and incrustation?

6. Is it requisite to have a hand-pump fitted to the boilers; if so, for what purpose.

7. Explain the use of the gauge-glasses and gauge-cocks, fitted on the boilers.

8. If the mercury was blown out of the steam gauge by the pressure of steam in the boilers; what would you apprehend was the cause?

9. What would you do to relieve the pressure of the boilers?

10. How would you regulate the height or quantity of water in the boilers?

11. When the steam is up, how is the feed applied to the boilers?

12 When it is not up, what is necessary to be done before the fires are lighted?

13. When the engines are stopped, what precautions are necessary with regard to the water in the boiler?

14. What is meant by a boiler priming?

15. How would you prevent it doing so?

16. If the water in a boiler is suffered to get too low, what may be the consequences?

17. What height should the water stand in a common boiler above the flues?

18. What height should the water stand in a tubular boiler above the tubes?

19. If any of the tubes were damaged by the fire or leaky, what would you do, supposing you could not shift them?

20. How do you detect the pressure of steam in a boiler?

21. If the water in a boiler is suffered to get too high, what might be the consequences?

22. How would you know when the water in the boiler requires changing?

23. Explain the use of the thermometer and hydrometer.

Engines.

24. Explain the use of the cylinders.

25. Explain the use of the air pump.

26. Explain the use of the condenser.

27. Explain the use of the eduction pipe.

28. Explain the use of the hot-water cistern.

29. Explain the use of the piston, and how fitted.

30. Explain the use of the stuffing box and glands.

31. Explain the use of the parallel-motion rods

32. Explain the use of the excentric, and how fitted.

33. Explain the use of the starting lever.

34. Explain the use of the barometer.

35. Explain the use of the steam gauge.

36. The vessel is alongside the wharf, proceed to get the steam up.

37. When the steam is up, how is it applied to the engines to set it in motion?

38. What precaution is necessary before the engine is set in motion?

39. How do you start the engine?

40. Is it necessary to move the engines by hand a turn or two before starting?

41. The engines being started, regulate the injection-cocks so as to keep them going at full or reduced speed.

42. What is the use of the injection?

43. How is the vacuum maintained in a condensing engine?

44. How do you know when there is too much injection?

45. How do you know when there is not enough injection?

46. If the injection was not shut off when the engines are stopped, what would happen?

47. If the condenser reject the injection, what would you do?

48. Would it be advantageous if an injection-pipe was fitted so as to take injection from the bilge, if required?

49. If water should get into the cylinder, what might be the consequences?

50. In running free with a heavy sea, and a jump upon the engines, what precautions would you take to endeavour to prevent damage to the engines?

51. If one engine was damaged, what would you do in order to proceed?

52. If the excentric should break, could the engines still be worked?

53. If a bearing becomes heated, what would you do?

54. How would you slow an engine?

55. How would you stop an engine?

56. Wherein does a high-pressure differ from a low-pressure engine?

57 How do you admit tallow into the cylinders, when the engines are at work, for the purpose of lubricating the pistons?

58. What is meant by working the engines expansively?

59. How would you disconnect the engines if there was no disconnecting gear fitted?

60. What is meant by throwing the engines out of gear?

61. Why have two feed-pumps fitted, say one to each engine?

62. Is it requisite to have branch-pipes fitted to the feed-pumps; if so, for what purpose?

The Engineer Examiner should provide drawings and working sections, on a sufficiently large scale, of the various parts of the steam-engine, and of the

valves and slides, &c. as may be necessary, and should require the applicant to make use of them in giving his answers to the various questions put to him; and if an opportunity offer, the applicant should be permitted, under the guidance of the Engineer, to start and stop an engine of some vessel which may have her steam up.

N.B.—LARDNER "on the Steam Engine," and Murray "on the Marine Engine," two books published in Weale's Rudimentary Treatises, give considerable information, in a very concise manner, on the foregoing Questions; but it must be borne in mind, that a *practical* knowledge of the Steam Engine will alone enable the Candidate to enter into all the details to the satisfaction of the Examiners; this practical knowledge can only be acquired by spending a short time in an Engineer's Workshop, or on board one of the numerous Steamers of our Coast.

Answers to Miscellaneous Questions in Arithmetic, pp. 15, 16.

1.	10,010,010	15.	25485917760000 seconds
2.	33972	16.	807098000
3.	845544960 inches	17.	100,060,409
4.	90660004	18.	760715
5.	909,040	19.	48777442560 inches
6.	239590	20.	6409010178
7.	311592960 ounces	21.	900,002,001
8.	60704090	22.	1005721
9.	104,090,009	23.	8793360000″
10.	185627	24.	2000007
11.	12934753920 barleycorns	25.	£2912 14*s*. 3½*d*.
12.	82090007	26.	·75 = ¾
13.	90,204,050	27.	£3635 2*s*.
14.	1029875		

Answers to the Exercises in Logarithms, &c. pp. 18, 19.

1.	3·829561	3·857332	4·640581	4·601038	5·602060
	$\bar{1}$·165244	$\bar{3}$·810904	0·588160	1·255417	$\bar{3}$·662758
2.	5·8672 +	6·6308 +	237·08 +	407·78 +	10016·37
	74·854 +	82·035 +	1259·7 +	1639·8 +	100340·4 +

3.	sine	9·867731	9·217122	8·504198
		9·978387	9·972463	8·246654
	cosine	9·907282	8·361681	8·246773
		9·972585	9·937470	9·505271
	tangent	9·613707	8·297036	10·109995
		9·879657	8·258262	10·348195
4.	cotangent	10·094133	9·783450	9·518992
		9·684753	10·793269	11·263849
	secant	10·028424	10·151822	10·503501
		10·059001	10·714159	10·104167
	cosecant	10·149446	10·025635	10·203770
		10·100598	10·061659	10·559516

5.	8°	43′	6″	78°	8′	50″	1°	39′	39″	4°	1′	28″
	77	14	19	15	31	22	41	12	21	84	40	38
	23	43	17	81	53	25	35	3	31	48	58	24
	61	3	33	7	34	15	76	40	15	88	20	53
	22	35	46	35	39	40	88	22	22	86	22	56
	50	57	26	60	13	52	1	57	4	5	43	39

6. 300
7. 4500
8. 6309
9. 2148
10. 7000
11. 324632
12. ·23105 +
13. 479·87 +
14. 3·8293 +
15. ·036902 +
16. 22
17. 70·6363 +
18. 12
19. 1
20. 10
21. 240·29 +
22. 1850
23. ·086956 +
24. 1·70648 +
25. 884403.6 +
26. ·129996

27.	2116	8836	·026569	·00005625
28.	103823	250047	·001295 +	·0000006382 +
29.	69·253	864·25 +	·80436 +	
30.	33·163	39·611 +	·91113	

31. £113. 2*s*. 11¼*d*.
32. £225. 18*s*.
33. 4*s*. 8½*d*. $\frac{2}{5}$
34. £7. 10*s*. 1½*d*. $\frac{6}{35}$

Answers to the Days Works. pp. 20 — 23.

1. Diff. lat. 54·3′S. : dep. 31·4′E. : Course S. 30°E. dist. 63′
   Lat. in 35° 45′S. : diff. long. 39′E. : Long. in 20° 41′E.
2. Diff. lat. 19′S. : dep [illegible]·5′W. : Course S. 71⅔°W. dist. 61·5′
   Lat. in 40° 10′N. : diff. long. 1° 15′W. : Long in 125° 47′W.
3. Diff. lat. 128·5′S. : dep. 11·8′E. : Course S. 5°E. dist. 129′
   Lat. in 27° 48′S. : diff. long. 13′E. : Long. in 45° 15′E.
4. Diff. lat. 22·6′S. : dep. 3·3′E, : Course S. 8°E. dist. 23′
   Lat. in 37° 58′S. : diff. long. 4′ : Long. in 150° 9′E.
5. Diff. lat. 60·8′S. : dep. 66·8′W. : Course S. 48°W. dist. 91′
   Lat. in 3° 23′N. : diff. long. 67′W. : Long. in 8° 53′W.
6. Diff. lat. 25·9′N. : dep. 16·4′W. : Course N. 33°W. dist. 31′
   Lat. in 34°S. : diff· long. 20′W. : Long. in 172° 18′E.
7. Diff. lat. 31·2′S. : dep. 10·7′E. : Course S. 19°E. dist. 33′
   Lat. in 26° 10′S. : diff. long. 12′ : Long. in 45° 19′E.
8. Diff. lat. 16′S. : dep. 159·2′W· : Course S. 84¼°W. dist. 160′
   Lat. in 34° 46′S. : diff. long. 191′ : Long. in 169° 38′E.

Answers to the Exercises for the Ordinary Examination.

PAPER I.—p. 27.

1. 3·514282 = 3268
2. 1·556302 = 36
3. Diff. long. 155·07′ +
4. Dec. 0° 1′ 0″N. Lat. 27° 40′ 35″N.
5. Course N. 56° 9′ 50″W. Dist. 6618 miles.
6. A. T. G. 6d. 1h. 36m. Dec. 22°30′S. True ampl. E. 23°23′55″S.
   Variation 5° 3′ 55″E.
7. 8h 10m. a.m. 8h 36m. p.m.
8. M.T.G. 6d. 8h. 8m. Dec. 22°28′S. True azim. N. 75°49′34″W.
   Variation 21° 20′26″E.
9. M.T.G. 5d. 18h. 57m. 30s. Dec. 22° 32′S. Eq. time 6m. 3s.
   A.T.S. 6d. 3h. 37m. 53s. Long. 131° 36′ 30″E.
10. A.T.G. 5d. 15h. 25m. Dec. 22° 33′S. Mer. zen. dist. 39°12′16″S.
    Lat. 61° 45′ 16″S.
11. N. 55°E. S. 71°30′E. S. 17° 30′W. N. 10° 5′W.
    N. 78° 10′E.
12. Dec. 16° 31′ 12″S. Lat. 35° 42′ 48″N.

PAPER II.—p 28.

1. 3·709524 = 5123
2. 0·301030 = 2
3. Diff. long. 132·06′
4. Dec. 6″N. Lat. 39° 39′ 14″S.
5. Course S. 73° 24′ 4″W. Dist. 2559 miles.
6. A.T.G. 30d 19h 38m. Dec. 4° 4′ 24″N. True amplitude, W. 4° 5′ 56″N. Variation, 7° 45′ 56″E.
7. 5h 33m. a.m. 5h 53m. p.m.
8. M.T.G. 26d 0h 30m. Dec. 2° 12′ 4″N. True azimuth, S. 57° 12′ 24″E. Variation, 16° 42′ 24″W.
9. M.T.G. 27d 23h 26m. Dec. 2° 58′N. Eq. time 5m 13·5s. A.T.S. 28d 3h 44m 24·5s. Long. 65° 54′ 30″E.
10. A.T.G. 5d 1h. Dec. 6° 2′ 17″S. Mer. zen. dist. 39° 42′ 3″N. Lat. 33° 39′ 46″N.
11. S.81° 10′E. S.61° 55′E. N.24°10′W. S.59°40′W.
12. Dec. 26° 6′ 22″S. Lat. 47° 25′ 37″S.

PAPER III.—p. 29.

1. 4·080482 = 12036
2. 2·041393 = 110
3. Diff. long. 98·01′
4. Dec. 6° 21′ 26″N. Lat. 35° 38′ 36″S.
5. Course N. 66′ 15′ 2″W. Dist. 3153 miles
6. A. T. G. 29d 2h 36m. Dec. 14° 29′N. True amplitude E. 16° 2′ 36″N. Variation 8° 12′ 24″E.
7. 9h 55m a. m. 10h 13m p. m.
8. M. T. G. 24d 23h 19m 30s. Dec. 13° 10′N. True azimuth N. 41° 51′ 30″ W. Variation 34° 41′ 30″W.
9. M. T. G. 15d 6h 6m. Dec. 9° 50′ 31″N. Eq. time 1s. A. T. S. 14d 20h 38m 12s. Long. 141° 57′ 15″W.
10. A. T. G. 20d 23h 17m. Dec. 11° 50′N. Mer. zen. dist. 28° 2′ 52″N. Lat. 39° 52′ 52″N.
11. S. 38° W. N. 49° 50′ W. N. 74° 20′ W. S. 3° E.
12. Dec. 22° 46′ 33″N. Lat. 20° 58′ 39″S.

PAPER IV.—p. 30.

1. 3·147429 – 1404·2
2. 0·561751 = 3·64545 +
3. Diff. long. 167·08′
4. Dec. 0° 8′ 14″N. Lat. 48° 9′ 22″S.
5. Course N. 63° 59′ 6″E. Dist. 6935 miles
6. A.T.G. 28d 1h 4m 30s. Dec. 19° 1′N. True amplitude E. 28° 37′ 6″N. Variation 14° 2′ 54″E.
7. 0h 29m a.m. 1h 3m p.m.
8. M.T.G. 31d 1h 6m 30s. Dec. 18° 18′N. True azimuth S. 78° 29′ 36″E. Variation 0° 9′ 36″W.
9. M.T.G. 28d 22h 6m. Dec. 18° 48′ 46″N. Eq. time 6m 11s. A.T.S. 28d 20h 57m 23s. Long. 15° 36′ 30″W.
10. A.T.G. 10d 1h 30m. Dec. 22° 15′ 41″N. Mer. zen. dist. 29° 27′ 29″N. Lat. 51° 43′ 10″N.
11. S. 81°10′W. N. 67°10′E. S. 48°48′W. N. 78°10′E.
12. Dec. 22° 5′ 25″S. Lat. 42° 29′ 52″S.

PAPER V.—p. 31.

1. 1·087213 = 12·224
2. 1·461899 = 28·966
3. Diff. long. 140·8′
4. Dec. 0° 3′ 18″N. Lat. 6° 10′ 57″N.
5. Course S. 57° 12′ 46″E. Dist. 5941 miles
6. A.T.G. Sept 30th, 19h 15m. Dec. 3° 5′ 10″S. True amplitude E. 4° 32′ 30″S. Variation 26° 27′ 30″W.
7. 10h 18m a.m. 11h 5m p.m.
8. M.T.G. 2d 0h 30m. Dec. 7° 57′N. True azimuth N. 51° 49′ 20″W. Variation 30° 39′ 20″W.
9. M.T.G. 1d 0h 19m 30s. Dec. 8° 19′N. Eq. time 5s. A.T.S. 1d 4h 4m 45s. Long. 56° 17′ 30″E.
10. A.T.G. 15d 14h 30m. Dec. 2° 49′ 50″N. Mer. zen. dist. 45° 25′ 40″S. Lat. 42° 35′ 50″S.
11. S. 70°25′W. S. 6°55′W. S. 66°42′30″E. N. 55°52′30″W.
12. Dec. 22° 19′ 22″S. Lat. 7° 13′ 23″N.

PAPER VI.—p. 32.

1 3·803048 = 6354

2. 1·079182 = 12

3. Diff. long. 102·1′

4. Dec. 0° 2′ 37″N. Lat. 32° 24′ 29″S.

5. Course S. 43° 37′ 35″E. Dist. 6514 miles

6. A. T. G. 15d 23h. Dec. 23° 20′S. True amplitude W. 31° 10′ 5″S. Variation 3° 39′ 35″W.

7. 11h 46m a.m. No p.m. tide

8. M. T. G. 16d 6h. Dec. 23° 20′ 44″S. True azimuth N. 83° 21′ 28″E. Variation 9° 21′ 28″E.

9. M. T. G. 15d 6h 15m. Dec. 23° 18′S. Eq. time 4m 32·5s A. T. S. 14d 20h 41m 39·5s. Long. 144° 28′ 15″W.

10. A. T. G. 15d 22h. Dee. 23° 19′ 53″S. Mer. zen. dist. 57° 7′ 34″N. Lat. 33° 47′ 41″N.

11. S. 76° 20′E. N. 61° 5′E. N. 23° 6′S. N. 24° 10′W.

12. Dec. 16° 12′ 55″N. Lat. 56° 5′ 49″N.

Answers to the Exercises for the Extra Examination.

MISCELLANEOUS,—pp. 70—74.

1. Moon's dec. 8° 15′ 29″S. Lat. 42° 4′N.

2. Moon's dec. 18° 44′ 7″N. Lat. 47° 27′ 31″N.

3. Moon's dec. 0° 4′ 21″N. Lat. 31° 3′ 29″S.

4. Sid. T. obs. 3h 5m 11·7s : 1st cor. —1° 16′ 2″ : 2nd cor. + 16″ 3rd cor. + 51″ Lat. 43° 49′ 25″

5. Sid. T. obs. 19h 7m 4·5s : 1st cor. —9″ : 2nd cor. + 2′ : 3rd cor + 49″ Lat. 60° 55′

6. Sid. T. obs. 1h 45m 47·7s : 1st cor. —1° 26′ 12″ : 2nd cor. + 3″ 3rd cor. + 25″ Lat. 52° 29′

7. Eq. equal alt. + 6·1s : Eq. T. 5m 44·88s : chron. slow on A. T. at place 1h 24m 24s. : slow on M. T. at place 1h 30m 8·7s : slow on M. T. at Greenw. 29m 4·8s

8. Eq. equal alt. —6·4s : Eq. T. 12m 24·13s : chron. fast on App. T. at place 1h 3m 2·7s : fast on M. T. at place 50m 38·5s : slow on M. T. at Greenw. 50m 49·5s

9. ☉'s mer. dist. 3h 27m. 20s. ☾'s mer. dist. 44m. 38·4s. ☉'s dec. 12°30′N. : ☾'s dec. 9°45′ 20″S. : ☾'s R.A. 23h. 20m. 11·45s : ☉'s true alt. 36° 54′ 55″ : ☉'s app. alt. 36° 56′ 4″ : ☾'s true alt. 39 1′ 10″ : ☾'s hor.par. 57′31″ : ☾'s app. alt. 38° 17′ 14″

10. Sid. T. obs. 8h. 21m. 46·94s. : ✱ R. A. 13h. 17m. 31·49s : ✱ dec. 10° 24′ 1″S. : ✱'s mer. dist. 4h 55m 44·55s : ✱'s true alt. 18°21′23″ : ✱ app. alt. 18° 24′ 14″ : ☾'s R. A. 9h 8m28·89s ☾'s dec. 21° 41′ 6·6″N. : ☾'s mer. dist. 46m 41·95s : ☾'s true alt. 18° 37′ 58″ : ☾'s hor. par. 54′ 43″ : ☾'s app. alt. 17° 48′ 48″

11. ☉'s dec. at mid. time 17° 21′ 41″N. : approx. lat. 46° 58′ : cor. for change of dec. in ½ elapsed time + 1′ 18″ : true lat. 46° 59′ 8″N.

12. ☉'s dec. at mid. time 11° 24′ 25″S. : approx. lat. 6° 5′ 5″ : cor. —1′ 2″ : true lat. 6° 4′ 3″S.

13. ☉'s dec. at mid. time 23° 5′ 27″S. : approx. lat. 52° 58′ 29″ : cor. —26″ : true lat. 52° 58′ 3″S.

14. ☾'s hor. par. 58′ 24″ : true dist. 107° 50′ 13″ : M. T. at Green. by lunar 18d 13h 19m 56s : app. T. at ship 18d 20h 45m 50s. : Eq. T. 14m. 10s. : Long. 115° 1′E. : chron. slow on M. T. at Greenw. by lunar 17m 6s.

15. ☾'s hor. par. 55′ 45″ : true dist. 60° 20′ 2″ : M. T. at Gr. by lunar 15d 1h 49m 10s : app. T. ship 14d 21h 35m 24s : Eq. T. 15m 15s. : Long. 67° 15′30″W. ; chron. slow on M. T. at Gr. by lunar 48m 12s.

16. ☾'s hor. par. 58′ 30″ : true dist. 84° 22′ 12″ : M. T. Gr. by lunar 9d 15h 46m 48s : M. T. at ship 9d 8h 35m 56s : Long. 107° 43′W.

17. ☾'s hor. par. 54′ 8″ : true dist. 80° 10′ 16″ : M. T. at Gr. by lunar 6d 6h 48m 46s : ♀ R. A. 23h 6m 7·43s : ♀ dec. 0° 12′ 18″N. : M. T. at ship 6d 5h 20m 46s : Long. 22°W.

18. ☾'s hor. par. 55′17″ : true dist. 82° 1′ 19″ : M. T. at Gr. by lunar 12d 1h 14m 54s : ♄ R. A. 3h 33m 12·72s : ♄ dec. 17° 10′ 23″N. : M. T. at ship 12d 10h 2m 2s : Long. 131° 47′E.

19. ☾'s hor. par. 60′ 12″ . true dist. 33° 2′ 31″ : M. T. at Gr. by lunar 3d 13h 42m 42s : M. T. at ship 3d 7h 40m 2s : Long. 90° 40′W.

20. N. 65°E. 93 miles

21. S. 11¾°E. 74 miles

22. N. 9°W. 36 miles

23. N. 77½°E. 18 miles

PAPER I.—p. 75.

1. ☾'s hor. par. 54′ 49″ : ☾'s R. A. 2h 15m 40·65s ☾'s dec. 10° 27′ 26″N. ☾'s mer. dist. 2h 55m 15·8s ☾'s true alt. 24° 52′ 30″ : True dist. 107° 58′ 41″ M. T. at Greenw. by lunar 7d 6h Chron. fast 20m 2s Long. 26°52′W.
2. ☾'s dec. 0° 5′ 40″S Lat. 38° 55′ 12″N.
3. Sid. time of observation 7h 9m 10·56s 1st cor. +57″ 2nd cor. +1′34″ 3rd cor. +1′ 32″ Lat. 54° 49′35″N.
4. ⊙ dec. at mid. time 4° 41′ 41″N. Approx. lat. 29° 59′ 51″ Cor. for change of dec. in ½ elaps. time +2′ 9″ Lat. 30° 2′N.

4a. 30° 1′ 49″N. taking Lats. 30° and 31°

5. Eq. equal alt. —2·6s Eq. T. —1·1s Chron. fast on app. time at place 6h 35m 37·5s Fast on M. T. at place 6h 35m 38·6s Slow on M. T. at Greenw. 3m 49·4s
6. 30° 51′ 38″
7. S. 71°W. 91 miles

PAPER II.—p. 76.

1. ☾'s hor. par. 59′ 25″ ☾'s R. A. 14h 10m 0·51s ☾'s dec. 10° 32′ 23·7″S. Sid. T. obs. 13h 4m 1·75s ☾'s mer. dist. 1h 5m 58·76s ☾'s true alt. 58° 14′ 48″ ✱ R. A. 10h 0m 35·85s ✱ dec. 12° 40′ 44·6″S. ✱ mer. distance 3h 3m 25·9s ✱ true alt. 23° 9′ 53″ True dist. 66°6′49·5″ M. T. at Gr. by lunar 10d 22h 24m 7s Long. 171° 6′ E.
2. ☾'s dec. 6° 4′ 5″S. Lat. 54° 58′ 23″S.
3. Sid. T. obs. 14h 34m 31·43s 1st cor. +1° 21′8″ 2nd cor. +11″ 3rd cor. +1′ 33″ Lat. 51° 14′ 22″
4. ⊙ dec. at mid. time 21° 28′ 30″N. Approx. lat. 3° 7′ 51″ Cor. for change of dec. in ½ elapsed time —51″ Lat. 3° 7′N.

4a. 3° 7′ 31″ taking Lats. 3° and 4°

5. Eq. alt. +6s Eq. T. 3m 53·8s Chron. fast on app. time at place 1h 58m 56s fast on M. T. at place 2h 2m 49·8s fast on M. T. at Gr. 8m 26s
6. 49° 7′ 40″
7. W. by S. 60 miles

PAPER III.—p. 77

1. Sid. T. of obs. 21h 11m 36·05s. ✱ R. A. 16h 20m 28·51s. ✱ dec. 26° 6′ 21″S. ☾'s R. A. 21h 48m 0·19s. ☾'s dec. 18° 45′ 16″S. ✱ app. alt. 28° 20′ 25″ ☾'s app. alt. 70° 30′ 20″ True dist. 74° 50′ 17″ Long. 18°E.
2. ☾'s dec. 7° 2′ 32″N. Lat. 30° 59′ 22″S.
3. Sid. T. obs. 8h 38m 18·2s 1st cor. + 34′ 3″ 2nd cor. + 1′ 3rd cor. + 1′ 6″ Lat. 47° 20′ 31″
4. ☉'s dec. at mid. time 13° 29′S. approx. lat. 40° 29′ 51″ Cor. for change of dec. in ½ elaps. time —1′ 51″ True lat. 40°28′S.

4a. 40° 27′ 45″S. taking Lats. 39° 30′ and 40° 30′

5. Equat. equal alt. —9·84s. Chron. slow on app. T. at place 2h. 34m. 19·8s slow on M. T. at place 2h 23m 12·8s fast on M. T. at Gr. 5h 17m 11·3s
6. 32° 51′ 6″
7. N. 35°W. 107 miles

PAPER IV.—p. 78

1. Jupiter's app. alt. 22° 6′ ☾'s hor. par. 57′9″ ☾'s true alt. 56° 32′ ☾'s app. alt. 56° 0′ 43″ True dist. 79° 48′ 41″ Long. 134°W.
2. ☾'s dec. 10° 3′ 1″S Lat. 33° 54′ 4″N.
3. Sid. T. obs. 0h 48m 49·25s 1st cor. —1° 27′ 14″ 2nd cor. + 1″ 3rd cor. + 49″ Lat. 54° 47′ 9″
4. ☉'s dec. at mid. time 7°10′30″N. approx. lat. 20° 48′ 41″ Cor. for change of dec. + 2′ 12″ True lat. 20°50′53″S.

4a. 20° 49′ 56″S. taking Lats. 20° 1′ and 21° 1′

5. Eq. equal alt. + 5·86s Chron. slow on app. time at place 2h 38m 10s slow on M. T. at place 2h 30m 30·6s fast on M. T. at Gr. 7h 8m 33·4s
6. 40° 7′ 49″
7. S. 6°W. 64 miles